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ABSTRACT

The Teacher Leadership Project (TLP), funded by the Bill & Melinda Gates Foundation, is a program developed to assist teachers in their efforts to integrate technology into the school curriculum. The program also encourages and facilitates teachers in assuming leadership roles to help schools and districts develop and implement technology plans, and to provide training in using technology. During the 2000-2001 school year, approximately 1,400 teachers participated in the TLP. Of these, 1,000 were new to the program, while the others participated for a second, third, or fourth year. This evaluation of the TLP focused on the following six research questions: (1) Are the teachers integrating and using the technology as intended? (2) How have teachers' technical skills developed over the year? (3) What effect has the training had on teaching, the classroom, and the school? (4) What percentage of the teachers can be categorized as "technology integrated?"(5) What leadership activities have the teachers performed during the year? and (6) What is the appropriate use of the technology for K-2 students? Data were gathered from several different sources: teacher journals from both new and experienced participants; interviews and observations of K-2 teachers and their students; and survey data from the TAGLIT (Taking a Good Look at Instructional Technology), an online instrument designed to measure teacher and student use of and attitudes about technology. (Contains 28 references.) (MES)

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Teacher Leadership Project 2001
Evaluation Report

July 1, 2001

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Jeffrey T. Fouts
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Executive Summary

Teacher Leadership Project 2001: Evaluation Report

Carol J. Brown
Jeffrey T. Fouts
Amy Rojan

The Teacher Leadership Project, funded by the Bill & Melinda Gates Foundation, is a program developed to assist teachers in their efforts to integrate technology into the school curriculum. The program also encourages and facilitates teachers in assuming leadership roles to help schools and districts develop and implement technology plans, and to provide training in using technology. During the 2000-2001 school year, approximately 1400 teachers participated in the Teacher Leadership Project. Of these, 1000 were new to the program while the others participated for a second, third, or fourth year. The evaluation of the TLP focused on six research questions, and data were gathered from several different sources: teacher journals from both new and experienced participants, interviews and observations of K-2 teachers and their students, and survey data from the TAGLIT (*Taking a Good Look at Instructional Technology)*, an online instrument designed to measure teacher and student use of and attitudes about technology.

BACKGROUND AND SIGNIFICANCE

The use of computers continues to expand both in schools and in the workplace, and is, in fact, seen more and more often as a necessary component of a child's educational experience. As technology use becomes more widespread, close attention is being paid to the ways in which teachers and students use the equipment for teaching and learning. *How* to integrate technology meaningfully into the curriculum has become a primary concern of educators. Indeed, while the ratio of students to computers has reached "an all-time low of 4.9-to-1" (Meyer, 2001, p. 49), teachers do not necessarily feel prepared to use them effectively and efficiently. According to a recent report by the National Center for Educational Statistics, "82 percent of teachers said they were not given enough time outside their regular teaching duties to learn, practice, or plan how to use the computers and other technologies" (Meyer, 2001, p.50). The Teacher Leadership Project has addressed this need for the past four years by providing in-depth training in utilizing technology for teaching and learning to selected teachers in Washington State. Participating teachers are also given the hardware and software necessary to set up an integrated classroom. Follow-up training sessions during the first year afford teachers the opportunity to expand their skills, to share curriculum plans, and to participate in small-group seminars on specific programs and applications.

EVALUATION QUESTIONS

Evaluation Question 1: *Are the teachers integrating and using the technology as intended?*

The purpose of the Teacher Leadership Project is to develop instructional leaders who use their knowledge, skills, and experience with technology and curriculum to design and deliver integrated lessons to their students. They are expected to develop lessons focused on the outcomes found in the Washington State Essential Academic Learning Requirements, and to utilize computers as educational tools to help reach these requirements. This being the case, curriculum design is an important part of the project, and in fact, teachers do indeed spend a considerable amount of time planning lessons and looking for ways to integrate technology meaningfully into the curriculum. For second year participants this becomes a natural process, while first year participants must be more intentional in their efforts. Beginning integration efforts tend to involve primarily word processing, research, and presentation projects. As teachers and students gain experience, their efforts become more diverse, and include a greater number of math lessons, publishing projects such as newsletters and brochures, as well as the development of websites, and use of digital cameras. Teachers also make concerted efforts to connect with colleagues, parents and the broader community, hosting technology nights, open houses, science fairs, and training sessions for families where they share their technical expertise and equipment, and raise awareness of what students are capable of accomplishing with technology.

Are teachers using the technology as intended? The answer seems to be, unequivocally, yes. Although the first year in the Teacher Leadership Project is one filled with challenges, they are few when compared with the successes and rewards. Benefits are many, and there seems to be little doubt that the program has strengthened the school experience for students across the state.

Evaluation Question 2: *How have teachers' technical skills developed over the year?*

Over the course of the year, teachers' technical skills developed significantly. Many started the program with relatively little computer experience, but by mid-year, most felt competent using word processing and presentation software, the Internet and CD ROM for information access, and e-mail. They were less capable using spreadsheets, digital cameras and scanners. Teachers indicated that they would benefit from additional training in web authoring, databases, and multi-media.

Teachers were definitely *not* satisfied with the level of technical support they received from their districts during their first year in the TLP. While their skills increased dramatically, many were still frustrated with their inability to solve technical glitches that occurred during the school day. Most teachers were faced with limited technical support, and often had to wait long periods of time for what help they did get.

A large majority of the TLP participants responded positively throughout the year about the value of the training, technical and otherwise, that they received from the Teacher Leadership Project. As previous participants have observed, the sessions were organized, supportive, and offered a good balance of sharing, learning, and practice. The only complaint, as such, was that training did not continue beyond the first year. Teachers believe quite strongly that the TLP would be a stronger program if the professional development component were extended, a sentiment expressed by participants every year.

Evaluation Question 3: *What effect has the training had on teaching, the classroom, and the school?*

To determine how learning was changed due to the addition of computers, TLP teachers were asked to reflect on ways in which student learning looked different in a technology-rich environment. While teachers were not convinced that test scores were impacted because of the integration of technology into the curriculum, they were nevertheless confident that students were benefiting in other ways. Research skills, self-directed learning, collaborative skills, and higher-order thinking skills were some of the positive outcomes teachers saw as a result of the integration process. Students were more motivated to learn, were more enthusiastic about school and learning, showed greater persistence in doing their work, were more confident in their abilities and products, and took greater responsibility for their own learning. The quality of work produced by students was greatly improved because of the infusion of technology into the curriculum.

Teachers also reported that the training they received through the Teacher Leadership Project, as well as their experiences integrating technology into the curriculum during the first year, had a profound impact on their role in the classroom. Integrated classrooms tended to be far more student-centered, such that the teacher was the guide and facilitator of learning rather than the director. Teachers have responded positively to this change, and observed in a number of cases that they enjoy being "learning partners" along with their students.

Evaluation Question 4: *What percentage of the teachers can be categorized as "technology integrated?"*

As technology becomes more commonplace in K-12 classrooms, greater attention is focused on *how* that technology is used. In a recent survey dealing with use of technology, 35 percent of students questioned responded that "teachers *often* or *sometimes* let students use computers as a reward for good behavior in class" (Technology Counts, 2001). Teachers who participate in the TLP are trained, rather, to view technology as one more powerful tool to be used to support student learning. They strive to design educational opportunities where technology is a natural and seamless element of the teaching and learning process. Survey results and journal observations from teachers indicated that, by mid-year, two thirds of the teachers in the project felt that they were approaching this goal, and had made conscious efforts to integrate technology into the teaching and learning process. A smaller percentage of teachers felt that their integration efforts were natural and powerful. As one might expect, it was more often the second year TLP teachers who reached this seamless level of integration. Differences were seen when middle and high school teachers were compared to elementary teachers. Math seemed to be a more difficult subject area than language arts or social studies in which to infuse technology, for example.

Evaluation Question 5: *What leadership activities have the teachers performed during the year?*

TLP teachers and their students responded to the call to share their training beyond the confines of their individual classrooms. Whether they taught classes, offered technical assistance, made presentations, or served on technology committees, teachers shared their knowledge, skills, and resources to raise awareness and develop competencies in the area of technology integration. Many teachers found their leadership experiences to be personally and professionally rewarding, as well. For some, the TLP opened doors to important professional development opportunities, such as presenting at state education conferences. In the end, it appeared that the benefits of the leadership component of the TLP were far-reaching.

Evaluation Question 6: *What is the appropriate use of the technology for K-2 students?*

During the 2000-2001 school year, primary teachers (grades K-2) were included in the Teacher Leadership Project for the first time since it's inception. While there was general consensus about the need for placing technology in primary classrooms, there were also questions about the appropriate use of computers with young children. Educators and other professionals who work with and for young children have become more vocal over the years about the importance of developmentally appropriate practices for primary-age children, stressing the need for hands-on, concrete, interactive experiences. Are "traditional" activities, such as pencil and paper composition, coloring and painting, and exploring with math manipulatives neglected in primary classrooms when technology is added? Are there physical, social, or emotional risks involved when young children use computers on a regular basis? These are questions that prompted an in-depth study of K-2 TLP classrooms.

Teachers identified a wide range of benefits in utilizing technology with primary age children, including technical benefits (knowledge of programs and applications), academic benefits (reading, math concepts, writing), and attitudinal benefits (motivation, self-confidence, collaboration). Children learned quickly, and were able to produce many high quality products. While there were benefits for younger students, challenges and continuing questions about technology integration at the primary level also emerged. Developmental limitations such as ability to recognize letters and numbers, reading level, fine motor dexterity, attention span, and ability to work independently *do* seem to play a part in how much young children are able to accomplish with computers. For teachers, management of students and computers, as well as software and hardware issues presented the greatest challenges. Taken together, these factors result in integration models that look somewhat different at the primary level than they do in upper elementary and middle school classrooms.

While patterns of use, benefits, and challenges have become much more clear over the past four years regarding technology integration in intermediate and middle school classrooms, patterns at the K-2 level have just begun to emerge. It appears, for example, that young children can learn to navigate within and between programs, do basic word processing, design simple Power Point presentations, complete directed Internet searches, and practice basic skills. Questions remain about the necessary and appropriate hardware and software for primary classrooms, types of training that best support primary teachers in their integration efforts, and management strategies that work best with a classroom of 5-8 year olds. In light of these remaining questions, it seems prudent to continue the evaluation of the primary component of the Teacher Leadership Project.

Additional Findings

The evaluation of the Teacher Leadership Project focused on six research questions regarding the efforts of teachers to integrate technology into the curriculum, yet several other areas of interest emerged in analyzing the data. These included (1) specific successes and challenges identified by teachers in using the technology with students, (2) evidence of students' skills and attitudes related to technology, and (3) perceptions of teachers about the TLP and technology in general.

Teachers found the process of integrating the curriculum to be challenging, and discussed specifically the need for more time to explore software and plan lessons. They also felt challenged in what they could accomplish in the classroom, both because of limited technical support and because of equipment problems. As well, many of the TLP teachers struggled with room configuration and student management with a 4:1 ratio issues. *However*, although the challenges seemed overwhelming at times, the successes and rewards were far greater. Teachers saw significant improvement and growth in their student's behavior (motivation, independence, collaboration, self-direction), in their technical skills, and in their academic performance (writing, reading, problem-solving, math comprehension, and quality and quantity of work). As well, there were important changes to the classroom environment and in the relationship between teacher and students.

Data also gave insight into middle and high school students technical knowledge and skills, revealing that most were competent in the use of draw and word-processing software. A majority of students also felt confident in their abilities to use e-mail, the Internet and CD ROM and presentation software.

Finally, there is a strong belief among TLP teachers in the potential of technology to change the school experience for the better. Based on their own knowledge, as well as classroom evidence, they are generally convinced that student learning is transformed when technology is intentionally infused into the curriculum. Teachers are fiercely supportive of the TLP, and believe it is a high quality model of effective professional development.

CONCLUSIONS AND RECOMMENDATIONS

Evidence suggests that the TLP is an outstanding program, in terms of design, administration, and outcomes. Teachers are exceptionally well trained, and students are better equipped to meet both academic and non-academic goals due to their TLP experiences. Although the first year in the Teacher Leadership Project is time consuming and, at times overwhelming, the challenges are few compared to the successes and rewards. Benefits to students, teachers, schools, districts, and communities are many, and there seems to be little doubt that the program has strengthened the school experience for students across the state.

Recommendations

1. The training provided by the TLP to teachers, both in the initial summer session and in the follow-up meetings is absolutely essential to the success of the program. While the TLP was expanded considerably during the 2000-2001 school year (214 teachers in 1999-2000; 1000 teachers in 2000-201), the integrity of the training was maintained and even *strengthened* with the implementation of a strong curriculum development component. The direction taken by the TLP in using curriculum frameworks and essential questions as a basis for their training sessions (Wiggins and McTighe) should be continued, since it is likely that this will lead to a higher degree of seamless and powerful integration and greater success for students.

2. In addition, given the research base on educational reform it is suggested that the Teacher Leadership Project consider extending the training component. One year provides a good foundation. However, while motivation and enthusiasm for the program is high, research and experience indicate that 3-5 years of training and support are necessary for reform measures, such as the TLP, to become institutionalized.

3. As part of their training, teachers should be familiarized with both the strategic and philosophical shifts that are likely to occur when technology becomes an integral part of the curriculum. Instructional strategies, materials, assessment, student management, role and relationship of teacher and student, and types of lessons are all changed to some degree in an integrated classroom. Teachers must be aware of these shifts if they hope to maximize the potential of technology. (See Appendix A)

4. Technical support continues to be one of the most significant challenges to implementing an integrated curriculum. The TLP has been intentional in requiring participating school districts to provide such support to their TLP teachers. The extent to which program administrators can monitor and enforce this requirement will influence the movement that can be made by teachers, especially during the first half of the school year.

5. Given the sometimes significant differences in students and teachers perceptions about the place of technology in the classroom and it's impact on learning, it would behoove teachers to talk with *students* about the Teacher Leadership Project, if they are not already doing this. Students would benefit in knowing about the intent and structure of the program, and also about their teacher's strategies and goals for infusing technology into the curriculum.

6. Student survey responses indicated that they were seldom required to evaluate information gathered from the Internet for research purposes. Electronic references, like encyclopedias, yearbooks, or any other information resource, must be used wisely. It is imperative that students be taught how to assess material taken from the Internet for accuracy, relevance, and bias, especially since it is being used with such regularity in the classroom.

7. Teachers put considerable time and effort into developing meaningful integrated lessons and projects for their students. Observing the criteria proposed by Robyler and Edwards may be helpful to teachers in their attempts to maximize the potential of the technology. (See Appendix B).

8. Teachers are generally convinced that students are learning more due to their access to technology. While large-scale, longitudinal achievement data for TLP classrooms is lacking due to measurement constraints, teachers nevertheless should gather and monitor test scores and other evidence of student performance wherever possible. As more evidence is accumulated, it will become easier to quantitatively study the impact of technology-rich environments on student achievement.

Implementation of the TLP at the primary level was generally successful during the first year. However, several modifications would strengthen this component of the program, and are discussed below:

9. Given the short timeline for including primary classrooms in the 2000-2001 TLP program, it is understandable that some issues were not addressed as fully as they might have been. Training sessions, for example, did not completely meet the needs of K-2 teachers. Efforts should be made in future sessions to provide relevant and specific instruction for primary teachers.

10. Primary teachers should be provided with developmentally appropriate software, including but not limited to Word, Excel, and Power Point, and also Kid Pix,

Graph Club, and primary reference software. Should primary versions of School Kit become available, those too should be provided.

11. Given the challenge of monitoring young children on computers, it is unclear whether or not K-2 teachers require the same (4:1) ratio of students to computers as do intermediate and secondary teachers. It would be worthwhile to consider modifying the hardware that is currently provided to K-2 recipients. Teachers may be better able to support instruction in primary classrooms with a high quality presentation device, scanner, color printer, digital camera, Alpha Smarts, and *fewer* desktop computers.

12. Primary teachers appear to have questions and needs that are unique to their situations, and which cannot be addressed by intermediate and secondary teachers. It would be useful to establish a separate K-2 listserve so that primary teachers could easily share information and support.

13. While patterns of use, benefits, and challenges have become much more clear over the past four years regarding technology integration in intermediate and middle school classrooms, these patterns have just begun to emerge regarding primary integration efforts. In light of questions that remain about the use of computers with young children, it seems prudent to continue the evaluation of the primary component of the TLP for several years. Findings will benefit not only those involved with the TLP, but also the larger educational community.

14. Compile and distribute a "handbook" to each K-2 participant, to include:
    - Developmentally appropriate websites
    - Scope and sequence / scaffolding plan for introducing technology
    - List of developmentally appropriate, useful software
    - Recommendations on keyboarding instruction and/or programs
    - Room arrangements and space considerations
    - Student management strategies
    - List of reference materials related to primary integration

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Teacher Leadership Project 2001: Evaluation Report

INTRODUCTION

The Teacher Leadership Project, funded by the Bill & Melinda Gates Foundation, is a program developed to assist teachers in their efforts to integrate technology into the school curriculum. Administered by Northwest Educational Service District 189, the program also encourages and facilitates teachers in assuming leadership roles to help schools and districts develop and implement technology plans, and to provide training in using technology. During the 2000-2001 school year, approximately 1400 teachers participated in the Teacher Leadership Project. Of these, 1000 were new to the program while the others were participating for a second, third, or fourth year. The evaluation of the TLP focused on six research questions, and data were gathered from several different sources: teacher journals from both new and experienced participants, interviews and observations of K-2 teachers and their students, and survey data from the TAGLIT (*Taking a Good Look at Instructional Technology)*, an online instrument designed to measure teacher and student use and attitudes about technology.

Description of the Teacher Leadership Project

The Teacher Leadership Project was started in the summer of 1997 with a core of 27 teachers from schools across the state. Initial participants developed a vision, mission, and a model for creating technology-rich classrooms and integrating technology into the curriculum. Since that time, program funding has increased and the project has expanded considerably, adding 185 teachers during the 1998-99 school year, and 215 more teachers during the 1999-2000 school year. An additional 1,000 grade K-12 teachers from public and private schools in Washington were selected to participate in the program for the 2000-2001 school year, and it is anticipated that 2,000 more teachers will be added over the next two years.

Each TLP grant recipient receives, through their district, $9,000 worth of hardware and software, including a laptop computer, printer, and presentation device. Computers are provided at a 4:1 student to computer ratio, and recipients receive Office software, as well as Encarta Reference and Africana, Publisher, Front Page, and access to SchoolKit. Teachers are also provided with 11 days of training over the course of their first year in the program, attending a 5-day summer session, and three 2-day sessions during the school year. Training sessions are intended to help teachers (1) develop their technical skills, (2) design curriculum that utilizes technology and is aligned with the state's Essential Academic Learning Requirements, and (3) identify leadership opportunities for sharing their knowledge and skills.

TLP participants are grouped geographically for training sessions, and each "regional" group typically consists of 25-30 teachers. Regional coordinators, each of whom is supported by several other trainers, as well as a technical support person, lead the sessions. Coordinators and trainers come from within the TLP, having participated in the program for at least a year prior to taking on this leadership position. Teachers bring their laptops to training sessions, enabling them to share materials and experiment with software during their time together. Training sessions, which are held in hotel conference rooms across the state, are intense and include instructional time (philosophy, research, curriculum design and alignment, software and skills, etc), help desks (short sessions which are focused on specific technical issues), sharing, and goal setting. In addition to attending all training sessions, teachers also agree to participate in the evaluation of the project.

Each participant's school district must meet certain requirements to support their TLP teachers. Most importantly, the district must (1) agree to provide release time and classroom coverage so that teachers can attend training sessions, and (2) agree to provide technical support to maintain the equipment.

Background

The use of computers and related technologies continues to grow both in schools and in the workplace, and has, in fact, come to be seen as a necessary component of a child's educational experience. Indeed, the ratio of students to computers has reached "an all-time low of 4.9-to-1" (Meyer, 2001, p. 49). Almost all public schools in the U.S. have access to the Internet, and of those with Internet access, 98 percent are, in fact, connected (U.S. Department of Education, 2001, p.1).

"82 percent of teachers said they were not given enough time outside their regular teaching duties to learn, practice, or plan how to use the computers and other technologies"

However, giving computers and online capabilities to teachers and students does not inevitably improve a child's learning experience, nor do teachers *necessarily* feel prepared to use the technology effectively and efficiently. In fact, it has been reported that "82 percent of teachers said they were not given enough time outside their regular teaching duties to learn, practice, or plan how to use the computers and other technologies"(Meyer, 2001, p.50). In a related study, 88 percent of students who responded to a survey said that computers are either "extremely" or "very" important for career success. On the other hand, only 7 percent said computer knowledge was "extremely" important to do well in school, while 33 percent said they were "very" important to one's success in school. Clearly there is still progress to be made in utilizing the available technology wisely and appropriately (Doherty & Orlofsky, 2001, p. 45).

Research on Past and Present Use of Computers and Related Technology[1]

The computer was introduced into education in the 1970s and its first use had teachers and students learning to program. Since that time there has been an evolution of best practices. As software gained in sophistication, the computer became the tutor or surrogate teacher. Students followed the commands on the computer screen and received rewards for correct answers. They also began to learn through playing games and simple simulations. Teachers of writing discovered the value of using a word processor, and soon students were writing more and revising with ease. Other teachers saw the value of the computer in creating rich learning environments and had students using databases, spreadsheets, presentation and research tools across all subject areas. Next, the Internet impacted technology use. Suddenly there was a volume of knowledge available to students with access and a network of people throughout the world that enhanced communication and the exchange of ideas. Real problem solving in collaborative groups became the norm in some classrooms. Online courses were available and students in rural areas had expanded learning opportunities in a variety of subject areas. Previously abstract concepts could now be illustrated and manipulated because of technology advancements. A whole new learning environment became possible.

"Technology supports exactly the kinds of changes in content, roles, organizational climate, and affect that are at the heart of the reform movement."

Of particular importance to those involved with the Teacher Leadership Project is the potential for computers and related technological tools to be used in transforming the classroom, such that a student's educational experience is qualitatively improved. In the past decade, the use of computers has expanded from use primarily as an instructional delivery medium to use as a transformational tool and integral part of the learning environment. In fact, many proponents of the current reform efforts see technology as a vital component of a new educational paradigm in which the curriculum, teaching methods, and student outcomes are reconceptualized (Means, 1994). This view was adopted by the U.S. Department of Education at least as early as 1993. In "*Using Technology to Support Education Reform*" (United States Department of Education, 1993) it was stated that "technology supports exactly the kinds of changes in content, roles, organizational climate, and affect that are at the heart of the reform movement."

In these settings the computer and related technologies are serving at least four distinct purposes: (1) they are used, as previously, to teach, drill, and practice using increasingly sophisticated digital content; (2) they are used to provide simulations and real world experiences to develop cognitive thinking and to extend learning; (3) they are used to provide access to a wealth of information and enhanced communications through the Internet and other related information technologies; and (4) they are used as productivity tools employing application software such as spreadsheets, data bases, and word processors, to manage information, to solve problems, and to produce sophisticated products.

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[1] This section is taken from Fouts, J.T. (2000), *Research on Computers in Education: Past, Present and Future.*

One of the central components of school reform is the desire for higher academic standards and a stronger focus on higher order thinking, problem solving skills, and learning associated with "real world" applications. To accomplish these ends, a new learning environment for schools is necessary. Proponents of school technology assert that it is just that type of environment and those types of learning that are facilitated by the new technology. At the same time, there is a predominant belief that the traditional standardized tests are inadequate to measure the types of learning teachers are now being asked to teach. This has resulted in a demand for new assessment procedures for the learning outcomes. Those new assessments are taking the forms of projects, portfolios, demonstrations, and new standards-based tests.

The changing use of technology reflects the changes in understanding over the last two decades about how the mind works and how children actually learn.

The changing use of technology reflects the changes in understanding over the last two decades about how the mind works and how children actually learn. There is a strong base of basic research that supports these ideas. This research is derived from the findings of researchers in developmental psychology, cognitive psychology, linguistics, and neuroscience and coupled with the philosophical ideas of constructivism (Duffy & Cunningham, 1996). Taken together they serve as the basis for many of the current beliefs about what and how children should learn in school. "Our understanding of human learning has....evolved based on a wealth of evidence collected over a wide range of different domains and media from which a process based on the passive assimilation of isolated facts to one in which the learner actively formulates and tests hypotheses about the world, adapting, elaborating, and refining internal models that are often highly procedural in nature" (Shaw & President's Committee of Advisors on Science and Technology, 1998). The National Research Council's Committee on Developments in the Science of Learning articulated an idea central to this new understanding of human learning: "A fundamental tenet of modern learning theory is that different kinds of learning goals require different approaches to instruction; new goals for education require changes in opportunities to learn" (Bransford, et al., p. xvi). "These new learning opportunities should take place in learning environments that are student centered, knowledge centered, assessment centered, and community centered..."

Key conclusions:

- Because many new technologies are interactive, it is now easier to create environments in which students can learn by doing, receive feedback, and continually refine their understanding and build new knowledge.
- Technologies can help people visualize difficult-to-understand concepts, such as differentiating heat from temperature. Students are able to work with visualization and modeling software similar to the tools used in nonschool environments to increase their conceptual understanding and the likelihood of transfer from school to nonschool settings.

- New technologies provide access to a vast array of information, including digital libraries, real-world data for analysis, and connections to other people who provide information, feedback, and inspiration, all of which can enhance the learning of teachers and administrators as well as students (Bransford, et al. p. xviii-xix).

The best that can be said at this time is that there are some strong *perceptions* that students are learning more or achieving different learning outcomes in these transformed learning environments. These perceptions are the result of qualitative research, program evaluations, anecdotal information, and only a very few quantitative studies.

Are the assertions of the technology proponents correct? Does the introduction of extensive technology into classrooms facilitate transformation of the learning experience as envisioned by the advocates, and does the use of technology enhance the creation of new learning environments? And if so, do transformed classrooms facilitated by the use of technology produce positive learning results?

Research has shown that technology *can* have a positive impact on student achievement if certain factors are present, including extensive teacher training and a clear purpose. In recent years researchers have found that the technology can be an important component for creating exciting new learning environments for students, once again dependent on other factors such as:

- Lower student to computer ratio;
- Teacher ownership of the reform efforts;
- *Extensive* teacher training and planning time; and
- High levels of technological support

Unfortunately, these factors are often missing in school technology implementation efforts.

Summary. The best that can be said at this time is that there are some strong *perceptions* that students are learning more or achieving different learning outcomes in these transformed learning environments. These perceptions are the result of qualitative research, program evaluations, anecdotal information, and only a very few quantitative studies. Program evaluation studies have provided reports from teachers, students, and their parents about the learning increases resulting from technology use (Fouts & Stuen, 1997, 1999). They also report that technology seems to have the greatest effect on at-risk or normally low achieving students.

As technology finds its way into schools and classrooms at ever-increasing levels, close attention is being paid to the ways in which teachers and students use the equipment for teaching and learning. As educators look to the future they are no longer asking the question, "*Should* technology be used in education?" Instead, the focus is, "*How* can technology be used to transform the classroom and help students achieve at higher levels?" The Teacher Leadership Project was designed to train and support teachers in their efforts to transform classrooms with technology, using computers meaningfully as powerful tools for teaching and learning. The evaluation of the TLP continues to assess the degree to which the program is successful in doing this.

Technology in Primary Classrooms

Of particular interest to teachers, administrators, parents, and researchers is the role of technology in K-2 classrooms. This is particularly true for those involved with the Teacher Leadership Project, since primary teachers were included in the program for the first time during the 2000-2001 school year. How do teachers use technology to support the curriculum with students who are still learning to recognize letters and numbers? How do children whose fine motor skills are still developing use a keyboard and mouse? "Young children have needs that are real and different from those of older children and adolescents. Children from birth to age eight are learning rapidly, using all their senses and their entire bodies to take in sensations and take in the world around them" (National Education Goals panel, 1999). Educators and other professionals who work with and for young children have become more vocal over the years about the importance of developmentally appropriate practices for primary-age children, stressing the need for hands-on, concrete, interactive experiences. Are "traditional" activities, such as pencil and paper composition, coloring and painting and exploring with math manipulatives, neglected in primary classrooms when technology is added?

"Both critics and proponents agree on the importance of the early years in a child's physical, social, emotional, and cognitive development. Much of the controversy revolves around the specific needs of young children, and whether technology can support those needs, or will take away from essential developmental experiences."

Although there are presently no definitive answers to these questions, they have been the focus of considerable discussion. "Both critics and proponents agree on the importance of the early years in a child's physical, social, emotional, and cognitive development. Much of the controversy revolves around the specific needs of young children, and whether technology can support those needs, or will take away from essential developmental experiences" (Van Scoter, Ellis, & Railsback, 2001, p.1). According to Jane Healy, author of several books on learning and young children, "An atmosphere of hysteria surrounds the rush to connect even preschoolers to electronic brains" (1998, p.20). She is one of a growing number of professionals raising concerns about the impact of placing sophisticated technology in the hands of preschool and primary age children. "While some very exciting and potentially valuable things are happening between children and computers, we are currently spending far too much money with too little thought. It is past time to pause, reflect, and ask some probing questions" (Healy, 1998, p. 18). Those who challenge the assumption that technology must necessarily be a part of the primary classroom cite numerous potential problems that may result from computer use, including risks to:

- Vision (strain to the eyes, blurring, itching, double vision)
- Musculoskeletal systems (back, shoulder, neck, arm and wrist strain)
- Physical health (obesity due to lack of outdoor activity)
- Emotional, social, and personal health (working in isolation, addiction, lack of time for reflective thought, overstimulation, passive learning)
- Moral health (potential exposure to inappropriate advertising, internet sites, ease of plagiarism)

Specifically, it has been suggested that "Computers pose serious health hazards to children. The risks include repetitive stress injuries, eyestrain, obesity, social isolation, and, for some, long-term physical, emotional, or intellectual developmental damage…Children need stronger personal bonds with caring adults, yet powerful technologies are distracting children and adults from each other….. Children also need time for active, physical play; hands-on lessons of all kinds, especially in the arts; and direct experience of the natural world. Research show these are not frills but are essential for healthy child development" (Cordes & Miller, 2000, p.3).

Healy, for one, recommends that computers not be used in the education of young children in earnest until age six or seven. Why? Her research has shown that "If the computer can accomplish the task better than other materials or experiences, we will use it. If it doesn't clearly do the job better, we will save the money and use methods that have already proven their worth. In the case of the child under seven, there are few things that can be done better on a computer and many that fail miserably by comparison….. Because age six to seven represents such an important developmental milestone for the human brain, I believe it is a realistic stepping-stone into constructive computer use. In fact, for children above age seven, combining computer and manipulative activities may result in better learning. Younger children, however, are better off spending this valuable time in a physically and linguistically enriched environment" (Healy, 1998, p.218).

While challenges are being raised in the popular press, proponents believe that there is indeed a place for technology in primary classrooms, provided certain guidelines are observed. A position statement issued by the National Association for the Education of Young Children (NAEYC) provides insight into what is believed to be the appropriate use of computers for primary age children (NAEYC, 1996). The statement stresses that while there is always the possibility that computers will be misused (as with any tool), technology nevertheless *can* be used to supplement children's learning and development. "When used appropriately, technology can support and extend traditional materials in valuable ways" (NAEYC, 1996, p.2).

Further support can be found in a study done by the National Research Council on brain development and learning, in which it was found that "because many new technologies are interactive, it is now easier to create environments in which students can learn by doing, receive feedback, and continually refine their understanding and build new knowledge" (Bransford, Brown, & Cocking, 1999, p.xix). Indeed, primary age children can benefit in many ways from using computers, according to Susan Haugland, who has written frequently on issues dealing with children and technology. Most notably, motor skills, mathematical understanding, creativity, problem solving and critical thinking are potentially improved when technology is infused into the curriculum (1999, p.29). And while opponents worry that a child's social and emotional development will suffer because computers limit personal interaction, proponents argue that, rather, computers can be used to stimulate conversation and initiate collaborative projects. Use of the keyboard gives young children greater freedom of expression since they are not constrained by their limited fine motor skills (handwriting and drawing). Obesity and lack of exercise are problems that exist whether or not computers are present in the classroom, it is argued, and eye strain and other physical concerns can be addressed by monitoring the amount, and the ways in which children work at the computers. Finally, potential attention-deficit problems can be avoided by limiting screen time and selecting software that does not over-stimulate children.

A review of the literature on technology and young children reveals two important prerequisites for effective integration of computers into the primary classroom: teacher training and selection of appropriate software.

A review of the literature on technology and young children reveals two important prerequisites for effective integration of computers into the primary classroom: teacher training and selection of appropriate software. According to the NAEYC statement:

- The teacher's role is critical in making certain that good decisions are made about which technology to use and in supporting children in their use of technology to ensure that potential benefits are achieved.
- Teachers must take time to evaluate and choose software in light of principles of development and learning ….developmentally appropriate software engages children in creative play, mastery learning, problem-solving, and conversation…..(NAEYC, 1996).

Without a doubt, teacher training is critical to the effective and appropriate use of technology in K-2 classrooms. "The teacher's role is to set up the environment and activities, matching technology use to the curriculum as well as to the children's needs and interests. The teacher is less involved in directing the activities, and more involved in monitoring student activities, intervening as necessary to guide and pose questions that encourage thinking" (Van Scoter, Ellis, & Railsback, 2001, p.7). The literature consistently points to the importance of teacher-student conversation, where teachers mediate children's interactions with the computers. "From a Vygotskian perspective children's interactions with each other and with the teacher are an important part of the learning environment" (Clements, Nastasi, & Swaminathan, 1993). Indeed, the NAEYC guidelines on technology use with young children are "based on the Piagetian notion that children construct knowledge through interaction with materials and people" (NAEYC & NAECS, 1991). Teachers must not only be available to their students, but must be skilled in facilitating such conversations. This expertise comes, in part, from specific training, and it has been suggested that practical experience, as well as models, mentors, and follow-up are critical components of such training (Epstein, 1993). Evidence has revealed, however, that teachers are not given sufficient relevant training, nor do they feel prepared to use technology judiciously with their students. According to Gatewood and Conrad (1997), relatively few teachers receive adequate training to effectively integrate technology in the classroom. A study published recently by the National Center for Education Statistics reported that of those teachers polled for a survey on technology use in the 21st century, 82 percent felt they had not been given enough time to explore, practice with, and plan lessons using technology (NCES, 2000).

In addition to creating environments that support technology integration, teachers must also be skilled in selecting software that is appropriate for primary age children. "It is easy to become distracted by glitzy packaging and promises from manufacturers, losing sight of what is truly important: providing children with a sound educational tool for learning" (Haugland, 2000, p.13). Recommendations for age-appropriate software include identifying programs that (1) encourage exploration, imagination, and problem solving; (2) reflect and build on what children already know; (3) involve many senses and include sound, music, and voice; and (4) are open-ended, with the child in control of the pace and the path (NETC, 2000).

Educators, researchers, and child-development specialists disagree about the place of technology in the K-2 classroom. Opponents cite several potential hazards to placing technology in the hands of primary age children, including risks to a child's physical, social, emotional, cognitive, and moral well-being. Supporters, on the other hand, believe that computers and related technologies *can* support and enrich the educational experiences of young children. Used wisely, they contend, computers

- Are intrinsically motivating for young children, and contribute to their cognitive and social development (NAEYC, 1996)
- Can enhance children's self-concept (Haugland, 1999)
- Can lead to increased levels of spoken communication and cooperation Clements, Nastasi, & Swaminathan, 1993)
- Encourage leadership on the part of children and initiate more frequent interactions (Clements, 1994; Haugland & Wright, 1997).

Summary. Assuming the latter position is the more accurate one, the question, according to Haugland, is not *should* computers be used in primary classrooms, but rather "*how* computers are used. Selecting developmentally appropriate software and Websites is essential. As computers are connected with young children and integrated into their curriculum, the benefits to children become clear. If computer experiences are not developmentally appropriate, children would be better served with no computer access" (2000, p. 18). "Computers are reshaping children's lives, at home and at school, in profound and unexpected ways. Common sense suggests that we consider the potential harm, as well as the promised benefits of this change" (Cordes & Miller, 2000, p.3).

EVALUATION DESIGN

Evaluation Questions

The following research questions were the focus of the 2000-2001 TLP evaluation:

1. Are the teachers integrating and using technology as intended?
2. How have teachers' technical skills developed over the year?
3. What effect has training had on teaching, the classroom, and the school?
4. What percentage of teachers can be categorized as "technology integrated?"
5. What leadership activities have the teachers performed during the year?
6. What is the appropriate use of technology for K-2 students?

Data Sources

Data were gathered from several sources, including:

Teacher Journals. First year participants submitted reflective journals seven times over the course of the school year. Journals focused on five questions pertaining to the integration process. An average of 756 journals were received each month. Questions to which teachers responded are listed below:

1. How have you integrated technology into the curriculum?
    a) subject areas / units of study
    b) programs, applications

2. What has gone well in your integration efforts?

(Consider student, parent, administration, community response; specific activities...)

3. What challenges have you faced in your integration efforts?

(Consider technical issues; student, parent, administration, community response; time, space, and/or support issues)

4. What, if any, leadership or sharing activities have you and/or your students been involved in?

(Consider presentations, demonstrations, classes taught, etc)

5. What evidence, if any, do you have that suggests students are learning differently and/or more because of the addition of technology to the curriculum?

Second-year participants submitted journals twice during the year, reflecting on their continuing integration efforts. A total of 79 journals were received. Second year participants addressed the following questions:

1. How are you integrating technology into the curriculum during the second year?
2. How have your integration efforts been different during the second year?

3. What challenges have you experienced during the second year?
4. What evidence do you have that student learning is qualitatively different because of integrating technology into the curriculum?
5. What are your views on integrating technology into the curriculum? Have these views changed since beginning your participation in the TLP? If so, how?
6. In what leadership activities have you been involved during the year?
7. How has your school changed because of your participation in the TLP?
8. How has your role as a teacher changed because of the addition of technology to the curriculum?

TAGLIT (Taking a Good Look at Instructional Technology). First and second year participants and their students (grades 5-12) were asked to complete an online survey used to assess attitude, skill, and use of computers. The TAGLIT survey was designed to help educators and researchers understand and report ways in which educational technology is used for teaching and learning. Originally developed for use in a professional development program (Principals as Technology Leaders; University of North Carolina Center for School Leadership), TAGLIT includes components for school leaders (principals), classroom teachers, and students. Data is gathered regarding teacher and student technical skills, classroom use of technology, school resources, and professional development in the area of technology.

The original evaluation plan called for a pre/post administration of TAGLIT to students and teachers, so that, to some degree, the impact of TLP training and resources on teaching and learning might be determined. Due to late delivery of the survey, however, a pre/post administration of the survey was not possible. That being the case, it was decided that TAGLIT would be administered once to all participating teachers, and to students in grades five through twelve.

A letter was sent to TLP teachers explaining the purpose of TAGLIT, instructions for completing the survey, and a timeline for administration. Online access to TAGLIT was made available from January 10 through February 16, 2001. Teachers of grades 5-12 were asked to administer the student version of TAGLIT to their students.

Of the approximately 1215 participating first and second year teachers, 893 completed the survey (a 73% response rate), while 11,400 students of TLP teachers took part (Table 1).

Interviews and Observations. Twenty-one teachers of primary-age students were selected for interviews and observations to understand how technology was used with young children. Each classroom was visited at least twice during the year, and most teachers were interviewed on three separate occasions.

Table 1: Teacher and student responses to the TAGLIT

Grade Level	Teachers	Students
K	29	NA
1	29	NA
2	44	NA
3	52	1
4	91	84
5	176	2671
6	104	2164
7	91	2039
8	89	1630
9	44	749
10	34	613
11	9	408
12	2	345
Other	9	696
Multi-grade	90	
Totals	**893**	**11,400**

RESULTS

Evaluation Question 1: *Are the teachers integrating and using the technology as intended?*

A total of 1,000 new teachers were selected to participate in the TLP during the 2000-2001 school year. To document how these teachers went about the work of integrating technology into the curriculum, they were asked to respond to a series of reflective journal questions throughout the year, sharing their experiences, observations, and feelings regarding the process. Specifically, an attempt was made to identify patterns of the ways in which teachers infused technology into their curriculum.

Use of Technology in the Classroom

Each participating teacher was provided with enough computers to reach a 4:1 student-to-computer ratio in the classroom, as well as Office software and access to SchoolKit. Teachers were allowed to use remaining funds for additional equipment, such as scanners and cameras. Analyses of journal responses revealed similarities in how teachers used the equipment, although there were some grade level differences. Beginning efforts generally involved lessons that could be accomplished with Word, Kid Pix, the Internet and other electronic references, Power Point, and Excel. Digital cameras were used frequently, although more often by elementary teachers than by secondary teachers. As they became more familiar and comfortable with the technology, their efforts expanded to include such applications as Publisher, Front Page, and selected SchoolKit lessons. Quite a few teachers used Accelerated Reading at the elementary and intermediate levels, and a number adopted Accelerated Math as well. Over the course of the year, students also learned hyperlinking, e-mail communication, and website design. While other programs and applications were used to a much lesser degree, Word, Kid Pix, Power Point, the Internet, Excel, Publisher, SchoolKit, Accelerated Reader, and certain subject-specific software programs were the basis of integration efforts, both for first and second year teachers. An analysis of technology use by grade bands follows.

Grades K-2. Primary teachers used their technology primarily for word processing activities (Word, Kid Pix), research (Internet, Encarta, Golden Books), and for presentations (Power Point). Excel was used to some extent in grades K-2, and subject-specific software (Reader Rabbit, Math Blasters, etc.) was also used for developing primary skills, such as letter and number recognition and basic math facts.

Students typically wrote and illustrated letters and stories with word-processing programs. They also were successful in using teacher-designed templates. Teachers worked with their students on simple graphing activities using Excel ("How I Get to School"), and to record daily weather conditions. Computers were also used frequently for (assisted) online research. While a few teachers reported that students could conduct their own basic searches, most found it more successful to pre-identify and bookmark sites for students to access during class time. Primary students did use Power Point for presentation purposes, although their product was typically a single slide, not a multi-slide show. Teachers used both Power Point and Excel as instructional tools as well.

Although difficult to quantify at this point, teachers are convinced that reading scores *will* be higher due to the integration of technology, and specifically to Accelerated Reader.

Journal reflections over the course of the year contained numerous comments on the benefits of Accelerated Reader. Teachers found the program to be highly motivating to students, particularly to those who would not normally be considered "readers." Although difficult to quantify at this point, teachers are convinced that reading scores *will* be higher due to the integration of technology, and specifically to Accelerated Reader. Primary teachers generally found SchoolKit lessons too sophisticated to be used without significant modification. Digital cameras were used extensively in grades K-2 to prepare class books or to record events such as field trips and class parties.

Selected journal excerpts give insight into K-2 teachers' integration efforts:

> *"We are still using KidWorks2 to practice writing the letter of the week. The program has a painting program that the students can select different tools to use to make the letter of the week we are learning about. Several students are venturing into the word processing portion of the program as well." (K)*
>
> *"The children are using the word processor to type their sight words from reading. I will be introducing the program Read, Write, and Play in the next few weeks. It lets the children write a story using words or pictures and illustrations." (K)*
>
> *"Students are completing their PowerPoints. They have learned how to use graphic organizers, Word Art, Text Boxes, Inspiration software, Outlining, clip art pictures, paint, etc. They are now working on timelines using PowerPoint of Helen Keller's life and Harriet Tubman's life. We are also working on our China unit and students are creating travel brochures, post cards, animal reports, fact cards, customs and food collages using the computers. We will continue to do this through May and have an open house for other classrooms and parents to visit as students present their projects. We continue to sequence stories, problem solve and graph." (1)*
>
> *"This month we did a lot of word processing and editing on the computers. This included both reading and writing instruction. The students are getting quite competent at writing about the beginning, middle and end of a story on the computer. I also tried a few reading instruction CDs that I acquired. They did some wonderful exploring about*

tigers, dragons, and penguins since those were topics we were reading stories about. This is really working on the skill of putting facts into your own words. They are also learning to tell the difference between a fact and an opinion. The technology was a great help as we prepared for our Spring Conferences. The students took some reading tests and the reports that printed out were great and specific information for the parents. During math, they are learning how to construct the different geometric shapes on the computer and then labeling what they have created. I started this with a program on the server, then they moved quickly on to independent creations." (2)

Grades 3-6. Applications and equipment used most often at the intermediate level included Word, Power Point, the Internet and Encarta, Excel, Accelerated Reader, digital camera and scanner, Publisher and Hyperstudio. Intermediate teachers also found SchoolKit lessons valuable for developing conceptual understanding and reasoning abilities. Among those who specifically discussed SchoolKit, there was a sense that these activities would be particularly useful in preparing students for the higher-level thinking component of the WASL. Finally, intermediate teachers, like their primary colleagues, were happy with the results they attribute to Accelerated Reader.

Students in intermediate grades used technology for research, writing activities, presentations, reading, and math projects. The most common way in which technology was integrated at the intermediate level was having students research a topic, write a report, and then develop a presentation to share the information. Such projects integrated word processing programs, the Internet, Encarta, and Power Point. Besides reports, Excel was used for analyzing and presenting data in all content areas, and Publisher was used to create brochures, newsletters, and book reviews. Students also used Power Point to develop presentations for conferences, Technology and Curriculum Nights, school board meetings, and school assemblies. Subject-specific software was used across the curriculum for skill development and practice to supplement the basic Office applications, although not as frequently as in K-2 classrooms.

> ***"During math, they are learning how to construct the different geometric shapes on the computer and then labeling what they have created. I started this with a program on the server, then they moved quickly on to independent creations."***

Journal reflections illustrate what intermediate teachers and students did with technology:

"Social Studies/Writing: The students completed their research projects on the country of their choice—the range of skills they learned in Word varied according to their ability level. We did quite a bit of "chain link" teaching (which worked great!) They also learned how to use WordArt to create their title pages. Students presented traditionally.
Science: Students have used a variety of

> *resources to develop questions and answers about weather that we have incorporated into the Jeopardy template from SchoolKit. They LOVE this!!!! We will continue to use this across the curriculum.*
> *Math: Kids are using Mighty Math Number Heroes to practice geometry, probability, fractions, and math facts. (Self-pacing program.)"* (4)

> *"A project I used technology with this month has been in Social Studies and Language Arts. We were studying Benjamin Franklin and Colonial America when we discovered Poor Richard's Almanac. We used the world wide web to research it some more and zeroed in on many of his wise sayings. We were able to list many of them and then define them in our own words. I then used it as a writing exercise to write a short story or fable that illustrates one of the wise sayings, using the wise saying as a moral or lesson to be learned at the end of the tale. We used WORD to type, edit, and publish their stories. I have also used Excel as a table or spreadsheet to input data from a measurement project in Math. From that we created graphs."* (5)

Grades 7-12. The majority of TLP participants at the secondary level were teachers of core subjects: language arts, math, science, and the social studies, although there were those elective teachers who integrated technology into the arts, career planning, senior projects, and home and family life. As in primary and intermediate classrooms, Office applications were the most widely used. At the secondary level, however, it was more common to find teachers who relied on SchoolKit and other subject-specific programs. Math teachers, in particular, felt limited by the basic Office software and found SchoolKit and math websites to be essential to their integration efforts.

Language Arts. Language Arts teachers used computers largely for research, word processing and presentation projects. Students also developed electronic portfolios, published various pieces of writing, practiced grammar, and tracked reading progress. The programs and applications most often utilized were Word, PowerPoint, the Internet and Encarta, STAR, Accelerated Reader, Reading Academy, Publisher and SchoolKit.

Students used word processing applications to complete their written work, including research reports, essays, poetry, and letters. Online references were also important at the secondary level for gathering information and doing research. Power Point was used in conjunction with Word, the Internet and Encarta so that students could share projects in a summarized and graphic format. Middle school teachers and alternative high school teachers used Accelerated Readers to enrich their reading programs.

Language arts teachers were generally pleased with their integration efforts, as the different programs seemed to naturally support and enrich traditional English and reading lessons. Management of the computers (4:1 ratio) was a more pressing concern than curriculum development, as the following journal excerpt suggests:

> *"Using sample work from each discipline, religion, language, literature, we developed a portfolio, which was used at the parent/student/teacher conference. We have written poetry, important incident narratives and descriptive papers. These were placed on their disks and I corrected on the disk, using the "insert a comment" feature on WORD. The kids loved reading the comments and edited immediately! A far cry from the usual of putting the hardcopy into a folder and forgetting it! The kids were actually excited to see what I had written and in many cases, when they saw the yellow highlighted word in their text, I saw them nodding their head to indicate that they already knew their error. It was very encouraging for me!"* (7th Grade, Private School)

"I am pleased to report that from the response of the students, both written and verbal, that they not only enjoyed the freedom and responsibility of the assignment, but also the opportunity to have a thoughtful discussion within the framework of the Socratic Seminar. As you can imagine the computer was an invaluable tool for this unit."

The following in-depth journal excerpt is a good example of how technology can be used as a *tool* to enhance a high school English lesson.

> *"For the first time all year, I finally found an opportunity to utilize the computers in my 10th grade honors English class. During one of the Gates weekends, I had the opportunity to work on a project that would synthesize the reading of* **Frankenstein** *by Mary Shelley, a new teaching format called Socratic Seminars, and research and group work using the computers. Each class was divided up into three problem solving groups. Each group was given essential questions to guide their research. One group focused on the events in Mary Shelley's life that contributed to the writing of this novel as well as looking at the genre of Romanticism. In addition, they looked at the concept of the novel usurping the role of women with his creation of the "monster". The second group focused on the philosophies of Locke and Rousseau and how they applied to the novel. In other words was the monster more of a product of nature or nurture? The last group focused on the issue of bio-ethics. They looked at the question of are there places that science should not go? Should there be limits to human experimentation? Is "Frankenstein" happening today? With all three groups, the novel would be the basis of the research. The unit was designed around a model that was taught at the Gates weekend in February. It not only helped me organize the unit's expectations, but to look at the time frame, materials, individual as well as group responsibilities, plus rubrics for the research, Socratic seminar, and position paper that culminated the project. I am pleased to report that from the response of the students, both written and verbal, that they not only enjoyed the freedom and responsibility of the assignment, but also the*

> *opportunity to have a thoughtful discussion within the framework of the Socratic Seminar. As you can imagine the computer was an invaluable tool for this unit. Each team had a computer at their disposal to research and write. I also found students utilizing reference books in the library more than they had this year, which provided a wonderful way to share the computers during the class time. I also noticed that since the information was quickly obtained, the students had more time to sit and discuss, analyze and synthesize the essential questions and how they related to the novel. As I walked around the room, I was amazed at the level of discussion as well as the inclusion of every student – for some reason even my more reticent students felt armed with enough research to be able to defend their positions as they tried to decide was the monster responsible for his behavior or was the environment in which he was "raised" the greatest indicator of his future violence. The best part for me as a teacher was the opportunity to be an observer – not a discussion leader or even for the most part a facilitator. It reinforced the importance of the modeling of analyzing literature that had taken place from the beginning of the school year. In a very natural way, the students' confidence in their abilities grew as they realized how much they had learned about the process of researching, analyzing and writing about literature……… "* (10th Grade)

Math. Math teachers infused technology into their algebra, geometry, and basic math classes in a variety of ways. Students analyzed and presented data, solved various types of equations, manipulated geometric shapes, and practiced basic algorithms. Teachers reported that math websites were accessed for a wide range of problem-solving activities as well. Although math teachers sometimes had a more difficult time getting started with integration, they nevertheless found that technology significantly influenced students' conceptual understanding and skill development. Comments from teachers illustrate these findings:

> *"Incorporating computer activities into eighth grade pre-algebra is proving to be a real challenge. Other than remedial work and math games, the students are doing activities such as spreadsheets showing the wind-chill factor."* (Middle School)

> *"In Algebra and Advanced Algebra the students have used a spreadsheet to reinforce, observe, and discover various algebra concepts. In Algebra we used Microsoft Excel to find the length of a square cut out of each corner of a piece of paper that would produce the maximum volume. We also found out how much it would cost to drive a car so many miles. Formulas, organization, and zooming in were techniques used. In Advanced Algebra we solved systems of equations using substitution and linear combinations on Microsoft Excel. Using Appleworks Spreadsheet the students demonstrated the transformation (rotations, reflections, scale changes) of a polygon by using matrices."* (High School)

> *"Advanced Math students are using the graphing capabilities to explore complex functions by looking at parametric equations for x and y. They will begin a project that will require extensive use of these graphing capabilities. This project presents a scenario where they are to write a report concerning a proposed particle accelerator project to a congressional committee. In order to be able to complete the report they will need to use a number of graph to show that the proposal is flawed and then provide corrections that will make it feasible."* (High School)

> *"My 6th graders have been using the SchoolKit lesson called Tables Generator to learn some basics about Excel. They then apply their understandings to solve a puzzle about the stock market (that I got from our summer institute files). They have also used a template in Excel to explore a number puzzle called Diffy. 7th graders are continuing to explore symmetry with pattern blocks and in SchoolKit and on several web pages I've found. The pattern block designs exploration has really blossomed this quarter. Students are in charge of everything this time-taking photos, inserting them into PowerPoint, labeling them, organizing them – all the stuff I did last time. The only thing I did for them this quarter was to place the disks of photos onto a shared folder on the network so that all students could have access to all disks. It turns out that students enjoyed making their designs but weren't very good at remembering what they'd done, so next quarter I will change that. Each group will have a disk for the camera, and that will solve that."* (Middle School)

Science. Science teachers reported a wide range of integration activities, both in terms of content and programs. Teachers used technology to support lessons ranging from the scientific method and global warming to advanced biology and chemistry. Generally speaking, they were able to integrate technology into the curriculum with relative ease. For example, students in one middle school science class used technology to develop a digital field guide to their outdoor education site, which would be shared throughout the district. Students researched, photographed, sketched, and wrote descriptions of tree species at the site. Many science teachers commented that they were able to conduct labs in a much more efficient and productive manner using the computers. The most frequently used programs included Excel, Encarta, Internet Explorer, Word, Publisher, PowerPoint, SchoolKit, Inspiration, Print Shop, Paint, Publisher, Vernier, Airwatch Weather, and flash movies. Selections from journals offer concrete examples of integration efforts and experiences:

> *"In Physical Science students, while studying global warming, collected data from a website that gave the average monthly temperature of a city for the past 10 years. They graphed this data and, after determining the 12-month moving average, graphed this line also. They then had to*

> *determine whether the data supported the idea that global warming is occurring or not. Their report had to include other tests or research that could be done to further determine if there is evidence of global warming."* (High School)

> *"In my exploratory class, my students have used the technology to create data tables, graphs, and final reports too. Their data has been collecting water testing results from 4 local rivers and comparing their findings. They have also incorporated their own personal water samples to get more of a personal connection to their results. In this class, I have also had my students create a Power Point presentation on the Hydrologic Cycle. They worked in groups of 4 to research the cycle on Encarta and then created a Power Point presentation for the rest of the class. This turned out surprisingly well, considering not many of them had ever used this program before."* (Middle School)

> *"The other project was an Interactive Excel project. I scanned in a picture of a cross section of a leaf. It shows the epidermis, the different leaf cells, stomata, and veins. They had to describe and label each part of the leaf by using comment boxes. The second sheet was all set up for them. It had the title, a place to put their name, directions, and a place to type their essay. Students had to pretend that they got very tiny and were able to go inside of the leaf (similar to The Magic Schoolbus). From there they needed to travel to each part of the leaf, describe its function, and explain how it works in the photosynthesis process."* (Middle School)

Social Studies. Integration efforts in secondary middle and high school social studies classes consisted mainly of research-related activities, which resulted in written reports and slide show presentations. In some cases, students produced brochures and newspapers to share the results of their research. Programs and applications being used in social studies classrooms included the Internet, Word, Excel, Encarta, Encarta Research Organizer, PowerPoint, Publisher and SchoolKit. Reflections from social studies teachers provide interesting information about their work:

Integration efforts in secondary middle and high school social studies classes consisted mainly of research-related activities, which resulted in written reports and slide show presentations.

> *"I introduced my class to a research project on Iran and Iraq for geography. The project was designed to be discovery based for the students. My goal was for students to research information on Iran and Iraq to find out if they would be willing to build a business in that country. They were using introductory research skills (we will be doing a very involved research project this year), integrated with Reading and Writing skills and presentation approaches. Besides using the word processing programs*

> *(such as Word) for the written portion of the report, students used the Internet and Encarta for research, and then put the final presentation into Power Point slides. The students worked in groups and seemed to really enjoy this actively "hands-on" approach to learning something new."* (Middle School)
>
> *"On Thursday and Friday this week, I will introduce the second major project for American History, "It's the economy, stupid," using economic data from late 18th century Philadelphia to draw conclusions about how economics affected historical events like the American Revolution. They will take the data in Excel to create charts, but they must read and reflect to draw good conclusions. The final product will be a power point presentation, rich with content, of each group's conclusions."* (Middle School)
>
> *"We also tried the research organizer for the first time in conjunction with a social studies project to bridge the time between the signing of the Constitution and the Civil War. To get an overview of what led a new nation to bitter division in less than 75 years, groups of students are researching the decades from 1790 to 1850. They began with the dynamic timeline in Encarta and copied information into the research organizer. Then they were asked to summarize the copied information into their own words. This is truly an awesome tool. The students love that they don't have to worry about losing individual note cards like in the past. And the notecard format is there for them, so they don't forget to write in a main topic or source information. They really liked that the program prompts them for source information if the source is other than Encarta."* (Middle School)

Elective Classes. Although most secondary TLP participants taught language, math, science or social studies, there were fine arts, foreign language, yearbook, newspaper, and PE teachers involved in the program as well. Their integration efforts varied, but most were able to find ways to successfully use the equipment. Art teachers, for example, had their students create various designs using cut and paste or draw functions. They also had them visit sites such as the Metropolitan Museum of Art to see works of the masters.

Are teachers using the technology as intended? The answer seems to be, unequivocally, yes.

Foreign language teachers were by and large pleased with the ways in which they were able to enhance the curriculum with technology. Internet sites were particularly useful. Students could visit any number of sites in foreign countries to learn about the culture, as well as historical destinations. Computers were also used for word processing, publishing, and presentation projects. An example of a Spanish teacher's use of technology is shared below:

> *"In Spanish 2, the students have been investigating clothing in their current chapter. They extended their vocabulary by looking up a Venezuelan clothing catalog on the Internet and deciding how to spend $200 that was given to them and describe what they would buy, the fabrics and designs etc. After that, they each needed to pick out an outfit and design an advertisement for the outfit like it would appear in a catalog. They had to tell about the pieces of clothing, their unique features and price. Then they inserted their outfit onto a Word document and finished their page, giving their catalog department store a name and sufficient descriptions of each item. They printed off their "ad" and submitted it to me—the catalog editor. This was so much more meaningful with the technology because previously I might have used American magazines to cut up and make such a page—but with the technology, the students were able to look at actual Spanish language catalogs and all the clothing and accessories were very current. They could compare cultural influences on what's alike and different in style in the various countries and how much the item costs, because we also found a site where we could convert the country's currency into US dollars and see how the clothing prices compare to ours here, and to each others. It was a very enriching learning experience that accomplished its goal of increased exposure to clothing vocabulary and so much more because of the computers and the Internet."* (High School)

Summary

Are teachers using the technology as intended? The answer seems to be, unequivocally, yes. Although the first year in the Teacher Leadership Project is one filled with challenges, it is also filled with Herculean efforts on the part of teachers to infuse technology meaningfully into the curriculum. Not all first year participants reach a level of transformational integration, but they do make concerted attempts to design curriculum focused on state standards, and to utilize technology as a powerful support tool. Learning, if not the primary focus of early integration efforts, certainly becomes so as teachers gain experience with the technology and curriculum design. Benefits to students are many, and clearly it has changed the school experience for students across the state.

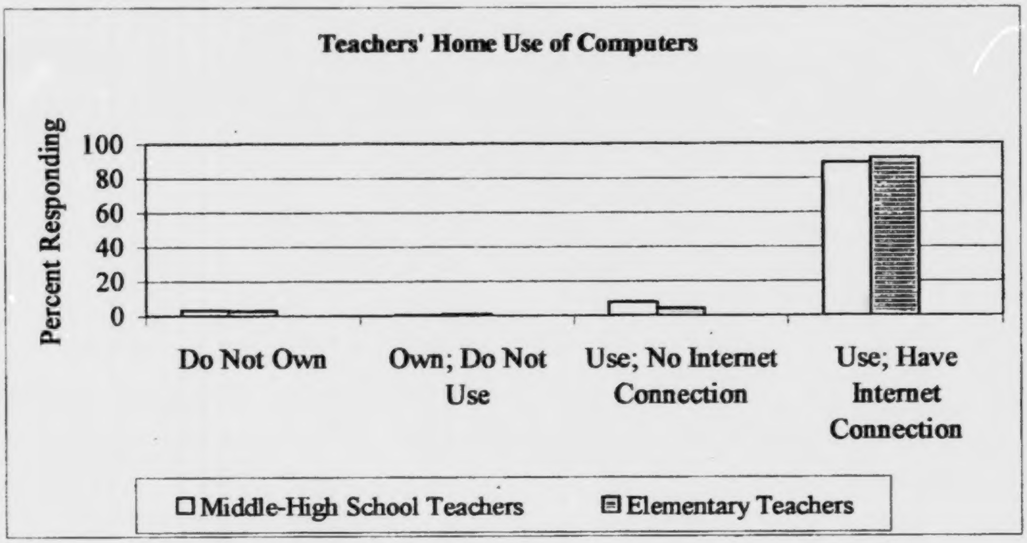
Evaluation Question 2: *How have teachers' technical skills developed over the year?*

Teachers began their participation in the TLP with varying levels of technical expertise. For some, the integration of technology involved learning not only how to design and implement a curriculum that maximized the potential of the computer, but also the basics of Word, Excel, Power Point, Publisher, and other frequently used software programs. In addition, they needed to develop their skills in using the Internet as a teaching tool. As such, their successes in using computers differed over the course of the year depending on the sophistication of their skills at the outset of the program.

Teachers' Technical Skills

Survey data gathered from the TAGLIT, administered in January, provided information about teachers' levels of expertise with various programs and applications. Results showed that nearly all TLP teachers had and used computers at home, and in most cases those computers are connected to the Internet (Figure 1).

Figure 1



Not surprisingly, by mid-year most teachers had confidence in their word processing skills, with a majority of both elementary (88 percent) and secondary (95 percent) teachers indicating that they would be comfortable teaching this application to others (Figure 2). They also felt competent using presentation software (Power Point), E-mail, CD ROM and the Internet (Figures 4, 5, 6, and 7). More than half were skilled using a digital camera and a scanner, and nearly that many were proficient with draw and paint software (Figures 8 and 9).

Figure 2

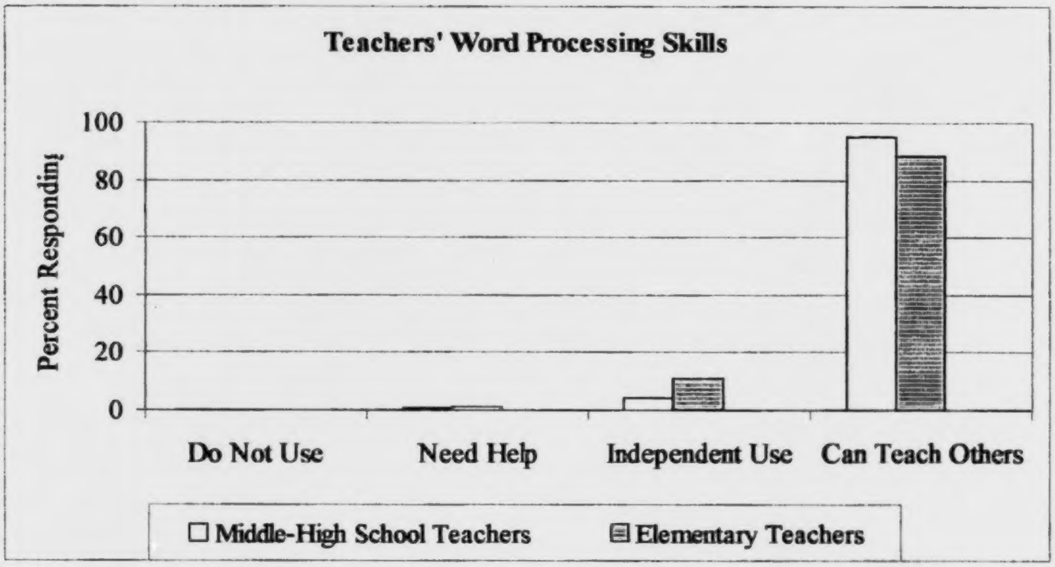


Figure 3

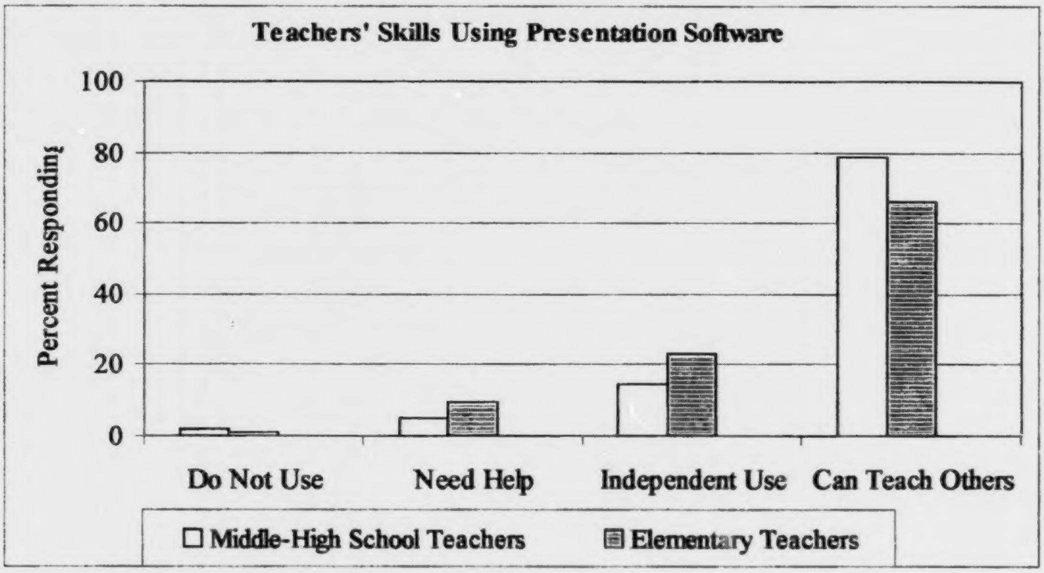


Figure 4

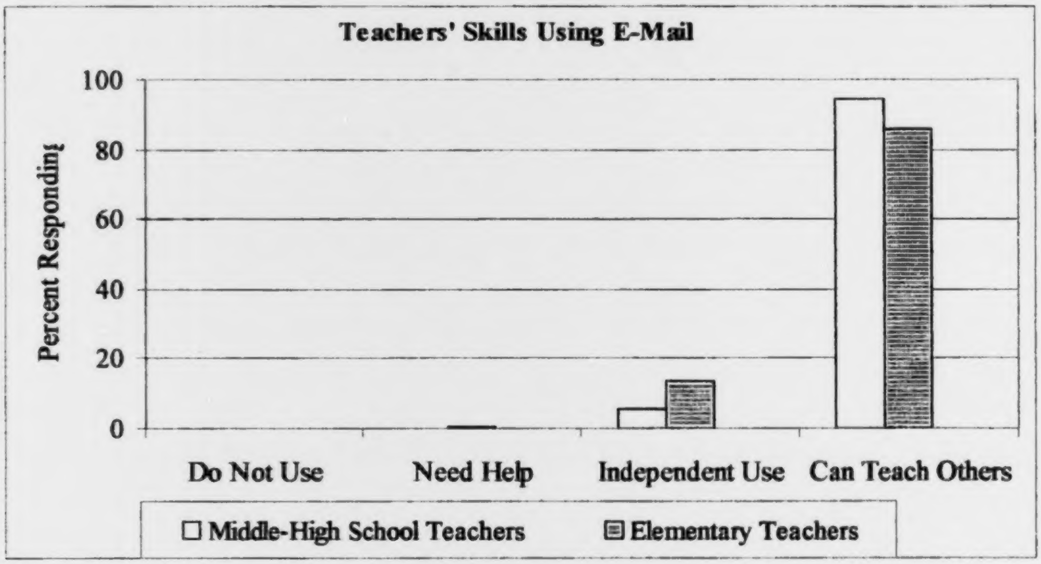


Figure 5

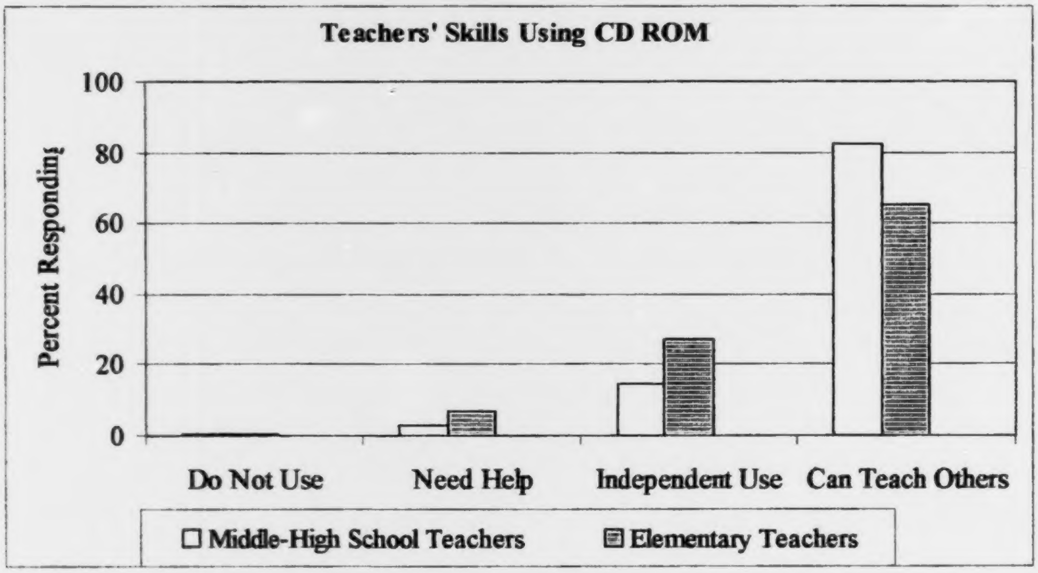


Figure 6

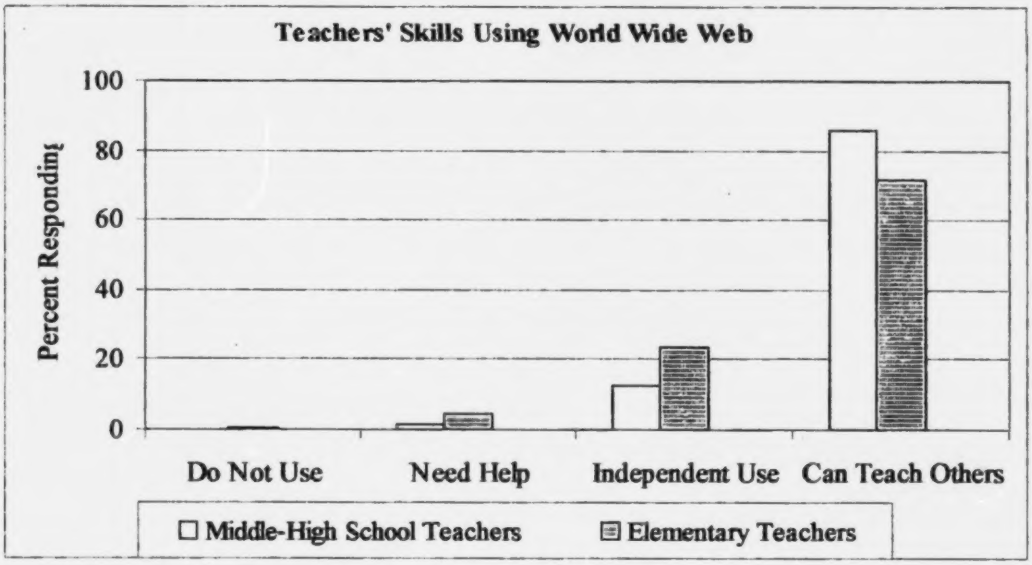


Figure 7

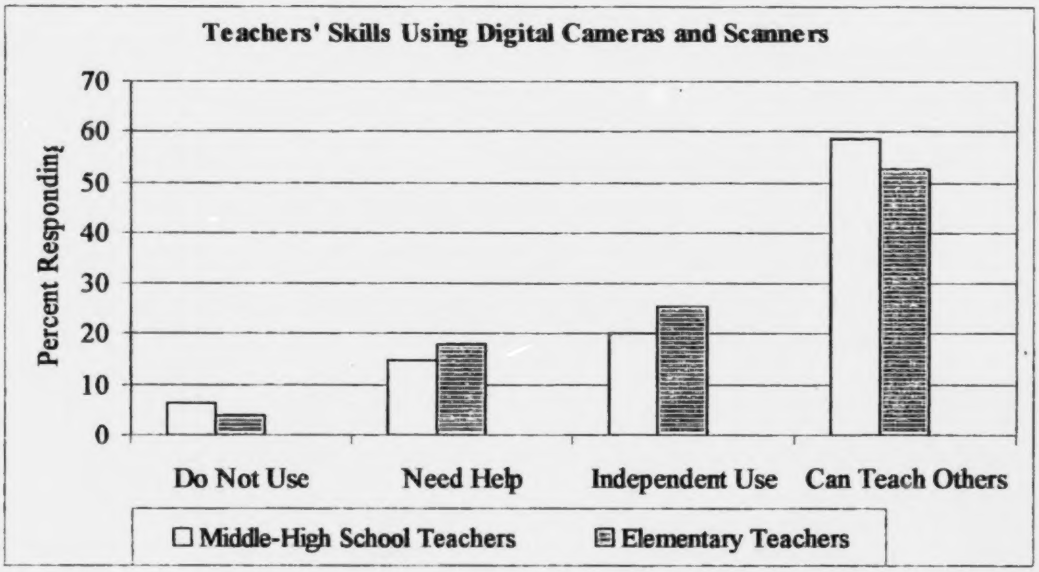
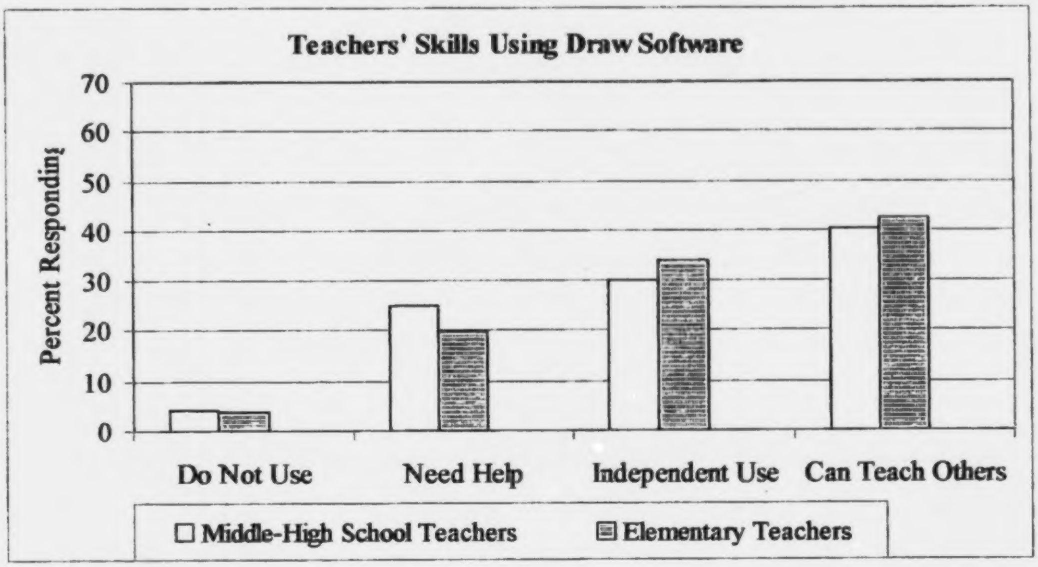


Figure 8



Teachers felt less capable using databases, multimedia, and in web authoring. Of those teachers who responded, less than one-fourth felt they had the expertise to instruct others in the use of databases, while slightly more felt they could teach multimedia skills. Only ten percent of elementary teachers and 23 percent of secondary teachers believed they had the ability to teach web authoring.

Teachers' journal reflections supported these survey results. Integration efforts during the first part of the year were most successful with projects that involved word processing (Word), presentations (Power Point), and research (Internet and CD ROM). Teachers were less confident about teaching lessons using spreadsheets (Excel). This was particularly true of elementary teachers. Finally, in their journals teachers shared numerous examples of projects that utilized the digital camera and scanner, and survey data would support that this was an area in which they felt fairly confident.

Technical Support

By far the biggest frustration at the outset of the school year was the length of time it took to order, receive, and set-up the technology. Teachers found the process inefficient, and were disappointed that they had to wait so long to actually start using the technology. Specific problems included the timeliness of ordering, the lack of communication about equipment orders, and finally the slow set-up due to limited tech support. Confusion about hardware specifications sometimes resulted in incompatibility issues. For example, some teachers found out too late that SchoolKit did not work with Macs.

Survey data indicated a high degree of dissatisfaction on the part of teachers regarding the technical support they received. More than one-third reported that their technical support was "not enough." This was true no matter whether it was related to ordering, getting set up, maintenance issues, or learning technical skills.

Teachers were divided on the quantity and quality of technical support they received. As has been the case in years past, smaller districts often had only one full or part-time tech support person to handle the needs of the entire district. Larger districts may have had more technical staff, but they also had more teachers to service, and as a result teachers often had lengthy waits for initial set-up and/or troubleshooting. While some teachers found outside help (spouse, children, high school students) to assist with set-up, this was not always possible since some districts limited any set-up procedures to the designated technical staff. In a few cases, teachers suggested that they were "put at the end of the list" to receive support, since the tech folks considered the TLP to be outside their primary obligations.

Survey data indicated a high degree of dissatisfaction on the part of teachers regarding the technical support they received. In all cases, less than five percent of teachers felt they had "plenty" of technical support. On the other hand, more than one-third reported that their technical support was "not enough." This was true no matter whether it was related to ordering, getting set up, maintenance issues, or learning technical skills (Figure 9, 10, and 11). Some teachers felt this could be at least partially solved by increasing the technical component of the summer training session.

Certainly this lack of support caused frustration for the teachers, and in some cases it limited what they were able to do with their students, as they indicated in their journals:

> *"Dealing with our technology person continues to be a challenge. Almost no progress has been made as far as completing the computer set up in my room…."*
>
> *"My computers are still not networked, so we can not do any file sharing, no work on the internet, and no printing… This is not a priority for my tech coordinator, so I get nothing done."*
>
> *"I know I would have begun to integrate more if I had the presentation device and my laptop was networked. There isn't a timetable for the networking so I'm not optimistic that it will happen before the first of the year. I was under the impression that the color printer in my room could be used with the computers but it can't be so I'm networked to the Laser printer in the hall. SchoolKit hasn't been installed yet and I seem to be missing lots of photos on Encarta. I'm trying to be patient, but I do want to get going more!"*

Figure 9

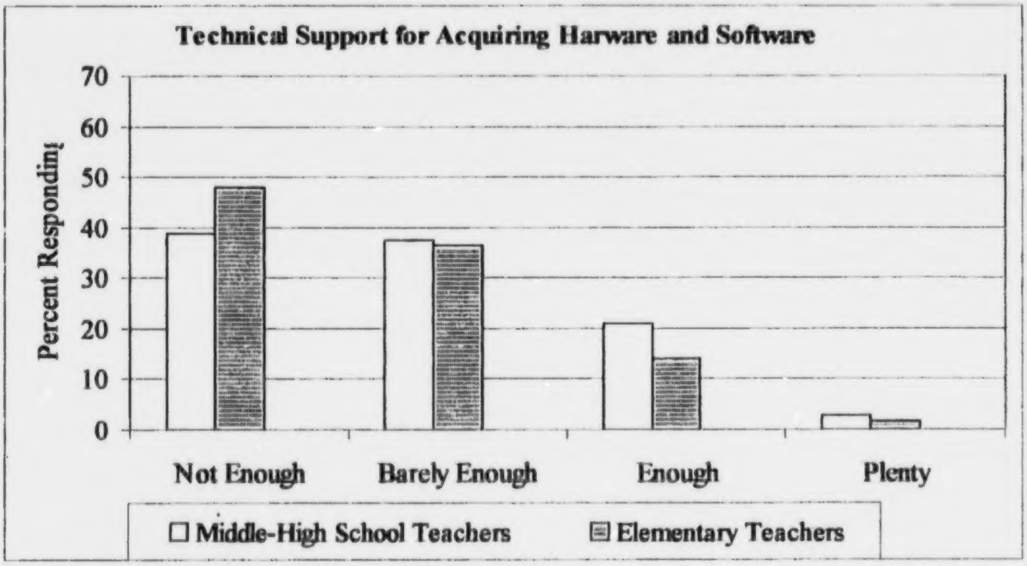


Figure 10

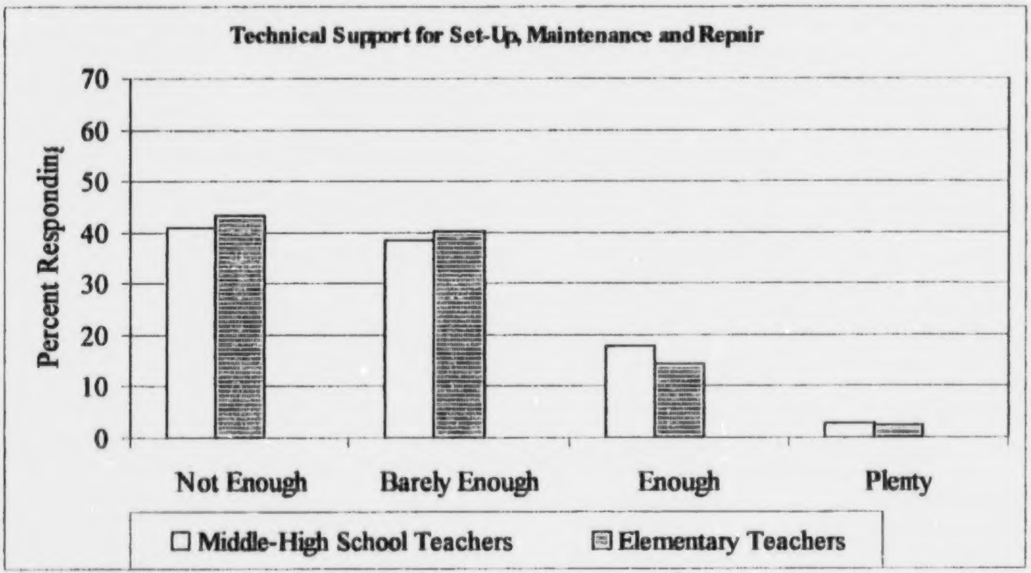
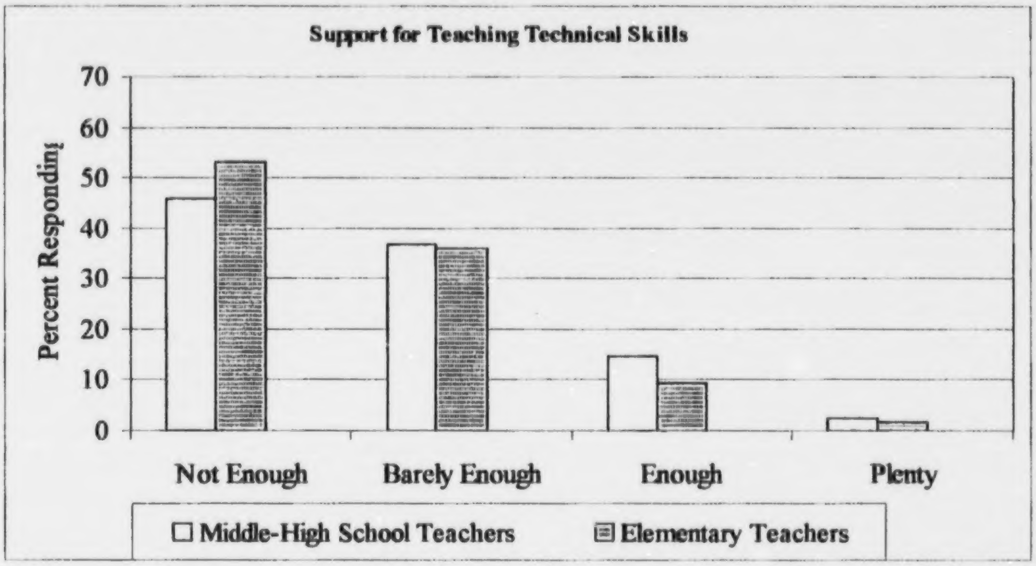


Figure 11



"Challenges? Currently I am feeling like it would have been easier had I not even bothered applying for my grant. My computers have just arrived on October 15th. This would have been acceptable had my district not told me they would be there the week before school started… The communication and support between the vendors, my district administration, my technical support personnel and myself has been inconsistent at best. I am continually told things will happen and they don't. Deadlines go by with no resolutions… Technical support personnel commit to ordering hubs or delivering my digital camera that arrived in July and repeatedly fail to follow through on their promises. I feel like a nuisance reminding them of unfulfilled commitments. There have been too many excuses and the road has been rough but I finally have seven computers in my room. Four of them are connected to our server and the rest are set to be hooked up as soon as the hubs we requested two weeks ago get ordered. I need time to explore my new equipment and transfer all of my old files to my new machines. I need time to explore the software provided through the TLP grant. Meanwhile I have a class to teach. I was so excited for the opportunity to use this new technology in my classroom and each day that goes by that I have to wait to get started deflates my enthusiasm a little bit more."

"Challenges? Currently I am feeling like it would have been easier had I not even bothered applying for my grant."

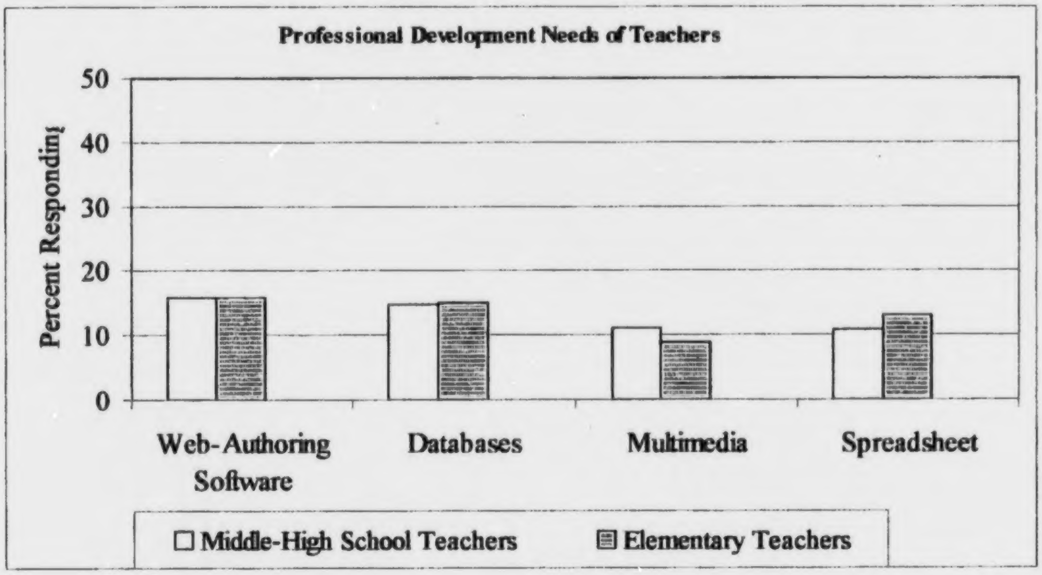
Professional Development

One important goal of the TLP is the development of participants' leadership skills so that they are able to share the principles of sound technology integration with others in the profession. The extent to which this is accomplished varies, and is discussed in a separate section of this report. Teachers do an admirable job of offering technical support, teaching classes, and serving on technical committees in their buildings, as well as sharing lessons and projects within the TLP. However, they also look for opportunities to expand their own skills by taking technology-related classes through the district, the ESD, or local universities.

Survey data revealed those areas in which teachers felt they needed additional training (Figure 12). Secondary teachers would like help with web authoring software (16%), databases (15%), and multimedia (11%). Remaining responses were divided between spreadsheets, cameras, and word processing software.

Elementary teachers' responses were similar, for the most part. They would like additional training in using web-authoring software (16%), databases (15%), and spreadsheets (13%).

Figure 12



Regional Meetings

The feedback from teachers regarding these training meetings was consistently and unreservedly positive.

One of the strengths of the Teacher Leadership Project is the training that teachers receive prior to, and during their first year of integration. Each teacher is required to attend a five-day training session during the summer following his or her selection into the program. During this time, the philosophy of the Teacher Leadership Project is shared, as well as research on teaching and learning with technology, and training in using the hardware and various software and applications. In addition, all teachers are required to attend three 2-day training sessions during the school year (October, February, and April). The feedback from teachers regarding these training meetings was consistently and unreservedly positive. Even though teachers were busy, overwhelmed, and stressed, they looked forward to the meetings for a number of reasons. First, the skills and knowledge they received seemed always to be relevant, useful, and timely. Second, participants were able to share projects, programs, teaching strategies, websites, and other information that proved invaluable in designing and teaching an integrated curriculum. Finally, teachers were enthusiastic about having a chance to talk with colleagues about technology and education. Rarely are they given the opportunity to dialogue about their work, and the fact that it was built into the TLP training was appreciated by teachers. The following observation is typical of those received from teachers following a training session:

> *"We just had our last TLP training in April, and I can't tell you how great those sessions have been. There was so much good information, help with programs, and great guidance that I will truly miss those meetings. They were like a lifeline for me. I was always glad to get those great ideas and hear how other teachers had the same frustrations that I did. I felt like I wasn't out there all by myself struggling. I am also glad to have other TLP teachers in my building to go to for help. It seems we each have something to share that is different from each other, and always someone to help."*

Summary

Most teachers selected to participate in the Teacher Leadership Project had, and used home computers that were connected to the Internet. They felt competent using and teaching word processing, presentation software, the Internet and CD ROM for information access, and the use of E-mail. They felt somewhat less capable of teaching with spreadsheets, digital cameras and scanners. Teachers indicated that they would benefit from additional training in web authoring, databases, and multi-media.

Teachers were not satisfied with the level of technical support they received over the course of the year and suggested that it would be helpful if the technical support agreement between the TLP and the district were strengthened and monitored. At times teachers felt powerless in connecting and communicating with their technical support personnel, and believed that their integration efforts suffered as a result.

The large majority of TLP participants responded positively throughout the year about the value of the training that they received from the Teacher Leadership Project. Given the frequency of technical problems, and the lack of tech support, however, some participants felt that more training in solving technical glitches would be beneficial. As previous participants have observed, the sessions were organized, supportive, and offered a good balance of sharing, learning, and practice. The only complaint, as such, was that training does not continue beyond the first year. Teachers believe quite strongly that the TLP would be more powerful if the professional development component were extended, a sentiment expressed by participants every year. There is support for this view. "Research has shown that technology *can* have a positive impact on student achievement if certain factors are present, including extensive teacher training and a clear purpose" (Fouts, 2000, p.i).

Evaluation Question 3: *What effect has the training had on teaching, the classroom, and the school?*

Certainly one of the most important questions to be asked about a program like the Teacher Leadership Project, in which large amounts of time and money are invested, is whether or not it impacts student learning. While the structure of the project makes the tracking of student achievement difficult, it is nevertheless important that an effort be made to understand how student learning changes because of the addition of technology to the classroom, if in fact it changes at all. To this end, teachers were asked to reflect on *if* and *how* student learning looked different. Specifically they were asked, *"What evidence, if any, do you have that suggests students are learning differently and/or more because of the addition of technology to the curriculum?"*

By far the most frequently teacher observed change in student learning, according to both qualitative and quantitative data, was an increased motivation for learning. This proved true across grade levels and subject areas.

Effects of the Teacher Leadership Project on the Classroom

Responses from teachers were hesitant and limited in scope during the first half of the year, noting primarily that students were excited at the prospect of having "lots of computers" in the classroom. While this excitement remained high over the course of the year, teachers began to observe other, more meaningful changes in student attitude and behavior as their use and experience with the equipment increased. These changes included:

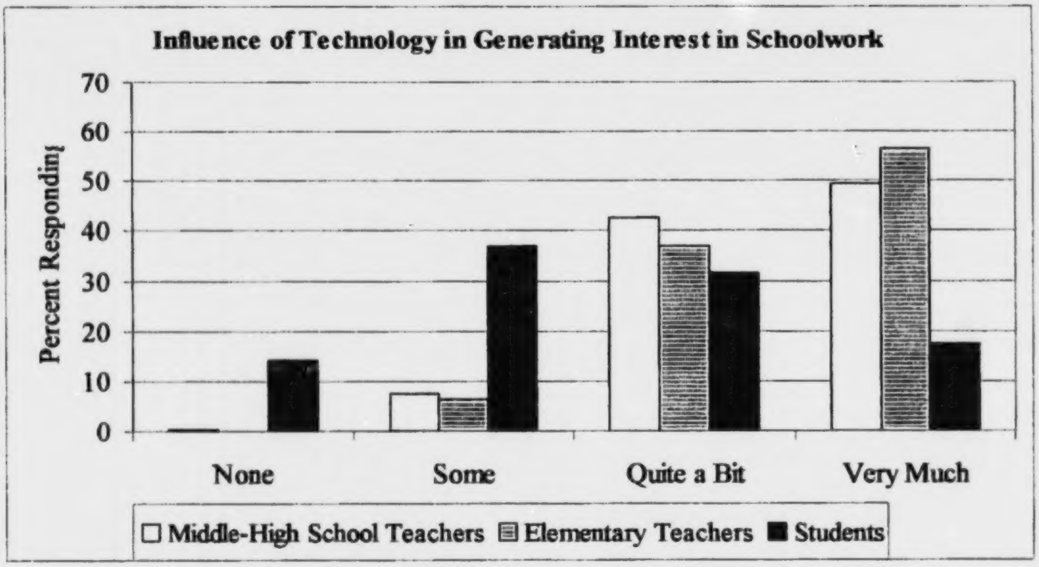
- motivation and enthusiasm for learning and school
- greater time on task
- self-directed, independent learning
- curiosity and desire to learn more
- higher degree of collaboration among students
- greater quantity and quality of written work
- increased willingness to edit and revise written work
- enthusiasm for traditional research activities
- better oral presentation skills
- increasingly sophisticated problem-solving and higher order thinking skills

Teachers also noted that students showed greater comprehension of certain concepts and skills, particularly in the areas of math and reading.

Motivation. By far the most frequently observed change in student learning, according to both qualitative and quantitative data, was an increased motivation for learning. This proved true across grade levels and subject areas. Initially this "motivation phenomenon" appeared to be simply an enthusiasm for using computers. Using Power Point to create a report was more fun than pasting pictures on a piece of poster board. Likewise, using Yahoo to get information was more fun than using the encyclopedia, and keyboarding assignments was more fun than writing with pencil and paper. In the long run, however, the importance of motivation seemed to be more than just an excitement about having and using lots of computers. For example, teachers found that the motivation to do work on computers resulted in kids spending more time on task. They appeared to be more engaged academically, and spent considerably more of their time gathering, reading, and processing information than in "pre-technology" days. If for no other reason than greater exposure to information, teachers believed that students were learning more. Kids also seemed to be more self-directed and independent in how they approached academic tasks, and teachers seldom found it necessary to remind students about finishing their work; they did it on their own. If they missed a due date it was likely because they were adding "just one more thing," not because they had put it off. Teachers also noted that students were more likely to search, on their own, for answers to questions that emerged during the school day. For example, teachers have long used "KWL" charts to launch units of study, focusing kids on what they know and what they want to know. This type of activity took on a whole new meaning when students knew they could use the Internet or Encarta in addition to traditional encyclopedias, atlases and the like.

While teachers were convinced that motivation and interest were significantly improved due to the addition of technology, survey data from students revealed that they were less certain (Figure 13). When asked if technology was influential in presenting engaging and interesting lessons, 49 percent of secondary teachers and 57 percent of elementary teachers indicated this was "very much" the case. On the other hand, only 17 percent of students indicated that technology was "very much" related to their interest in schoolwork.

Figure 13



Without more in-depth information from students, it is difficult to interpret these findings. Perhaps they find school interesting with or without the computers, or perhaps they believe that school is not interesting no matter what changes are made to the learning environment. In any case, it is curious that perceptions of teachers were students appear to be so different. Reflections from teachers give a sense of their perceptions:

> *"The motivational factor still is a powerful argument for the integration of technology into the curriculum. Students who formerly stayed out in the halls until the last bell, now arrive early and begin using the computer for a variety of interests, mostly searches for music and games. They are much easier to engage in the assigned work when they get to use the computer."*

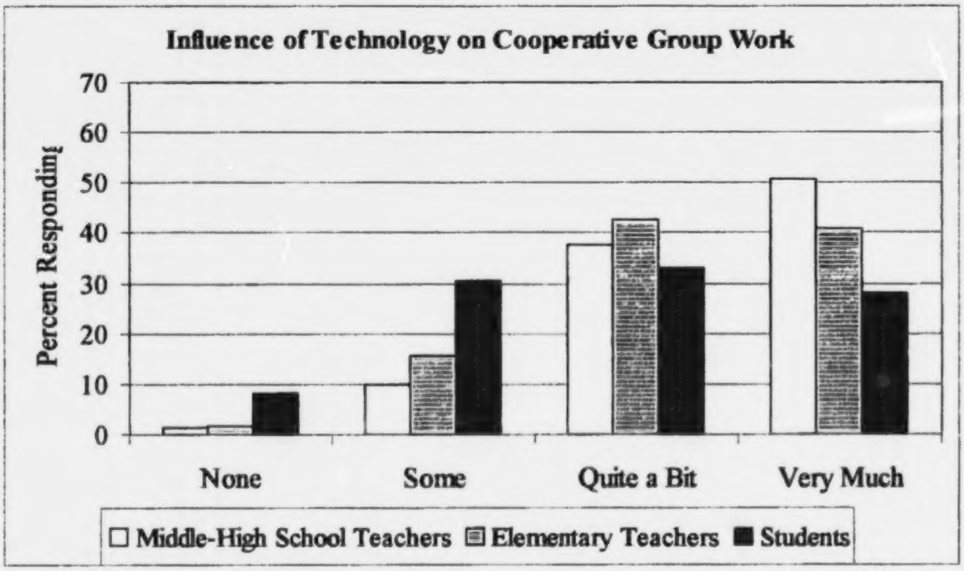
> *"On an individual basis, I have observed many children willing to be much more independent in their work. Last fall, the students wanted lots of direction in searching for research items. I see the children eager for independence, THINKING, evaluating, and summarizing their information."*

"I see the children eager for independence, THINKING, evaluating, and summarizing their information."

Collaboration. While motivation was clearly the most frequently cited positive change in how technology impacts student learning, the degree to which students collaborated on academic tasks was mentioned only slightly less often. Teachers felt that this was one of the most important benefits of technology integration, one that would serve them well in the future. Time and again, teachers shared examples of how students were willing to work cooperatively on assignments when technology was involved. Not only did they seem to collaborate more often in integrated classrooms, but they collaborated with students they typically would resist working with. Beyond this, teachers found that students were willing to go out of their way to assist their peers in solving problems or sharing information.

When teacher and student survey data were compared, results indicated that their perceptions were relatively similar (Figure 14). For example, 51 percent of secondary teachers and 41 percent of elementary teachers indicated that technology was very influential in fostering student collaboration, while 28 percent of students found this to be true. Again teachers were more convinced about the impact of technology than were students.

Figure 14



One teacher's comment sums up what others shared in their journals:

"They are using cooperative skills and networking with each other to complete the assignments. When one student is stuck, another student is often able to explain what to do, freeing the teacher to work one-on-one as needed with other students. The teacher is readily the "guide on the side" vs. the "sage on the stage" exactly as we learned in our methods classes."

Written and Oral Communication. The analysis of journal reflections indicated that both quality and quantity of student writing were positively impacted when students had access to technology. This finding was consistent with results from previous years, and was reported by both elementary and secondary teachers, although it seemed to be more evident at upper elementary than in primary grades. Teachers found that, particularly as students developed their keyboarding skills, they were inclined to write longer and more creative pieces (if creativity was indeed an element) when they had access to technology. This was due almost exclusively to their ability to edit and revise "painlessly." Many teachers recounted the "old days" when revising a paper usually meant starting from scratch. This might happen once during the writing of a story or essay, or it might happen multiple times. Whichever, it was a laborious and universally disliked task among students (and teachers, to a certain degree) and it inevitably limited the work that students produced. The difference when students had access to computers was significant. When they knew that they would be able to edit and revise a document without having to start over each time, students were willing to write more, *and* to make necessary changes. This was true across the board, but especially for students who struggled with fine motor skills. Keyboarding (except for primary-age students) was almost always faster than writing with pencil and paper, and being able to make spelling and formatting changes on the computer was much preferred to doing hard-copy drafts. All in all, teachers reported that the impact of technology on the writing process and product was considerable.

All in all, teachers reported that the impact of technology on the writing process and product was considerable.

"I know I've said this before, but I'm extremely pleased with how much easier it is to teach writing using technology. My lessons are clearer and better paced using the laptop and projector to teach. The kids are much more motivated to write knowing that their final product will be a "thing of beauty." Revision and editing is much less of a struggle—they are willing to put forth the effort knowing that they'll get the chance to word process once they have polished their piece."

"Computers continue to generate an enthusiasm for learning and allow a flexibility that is not visible with paper and pencil learning. My students seem more willing to edit a piece written on computer through several drafts than that written with paper and pencil. This really allows for the teaching of language skills and fine-tuning that were only seen in the top percentage of achieving students."

"I also saw much better revision/editing in the writing process. I think they realized it wasn't as hard to go back and make changes to improve their writing (which they are often resistant to when written out by hand). I have tried to stress/emphasize that it's a regular process real writers use all the time and that they go through many more drafts than we normally do. I think they really saw and understood more about how the whole writing process works. They had to turn in all the parts (web, hand draft,

> *typed draft, editing sheet (self and peer) and their final copy) of the process."*

As students did more and more presentations, oral communication was also improved, according to teachers. The more students used Power Point as a visual outline for sharing information, the more they learned about the appropriate balance between text, graphics, sound, and talk. As many teachers noted, students only had to watch and listen to a few presentations to really appreciate the fact that even the sound of screeching tires gets old. Using Power Point as an outline for oral presentations also seemed to encourage students to actually *learn* rather than just *report* the material they were studying. The fact that they were actively engaged in gathering, summarizing, and organizing the information appeared to lead to "deeper learning." The following journal selection illustrates how teachers perceived the benefits of technology:

> *"Students who in the past have spoken very quietly and had typical nervous behaviors, seemed much more at ease sharing with the help of the computer. It made it easier of other students to be good listeners with the visual to focus on while they were listening... I believe they also became very aware of what quality work looks like in PowerPoint. We focused on enhancing their words with appropriate pictures and limited sounds. I tried to emphasize with them how sounds are often quite a distraction. Only three or four of them seemed to miss that point and still included the typewriter sound or others with their transitions or as the text built. I felt like almost all of them understood how to enhance without bells and whistles."*

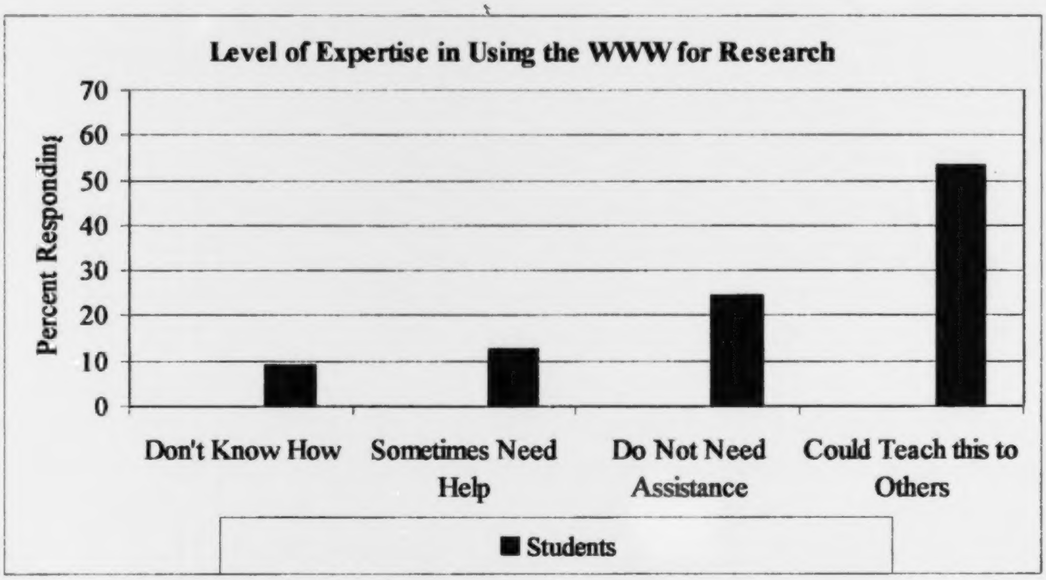
Research. Willingness and ability to do research-related activities was greatly enhanced when technology was infused into the classroom. Traditionally, a research assignment meant that students were expected to locate information, take notes, summarize, and report information from encyclopedias, atlases, dictionaries, and almanacs. While much the same when using online references, there was something so motivating about the process that it completely changed the way in which students approached it. Whether it was the immediacy of search results, the active nature of searching, the varied and current resources that could be accessed, or the graphics and sounds, students were enthusiastic users of electronic references.

Whether it was the immediacy of search results, the active nature of searching, the varied and current resources that could be accessed, or the graphics and sounds, students were enthusiastic users of electronic references.

Teachers shared anecdotes about students *wanting* and *asking* to do research-related activities. They stayed in from recess, worked before and after school, and designed independent projects so that they could utilize electronic resources. Both teachers and students appreciated the immediacy of web access, and more than a few teachers related anecdotes of how it supported the "teachable moment." For example, when an earthquake rattled communities throughout Western Washington, students were able to go directly to the Internet and find strategic information about the event, including magnitude, epicenter, and initial estimates of injuries and damage. Instances like these have become common in classrooms, such that whenever students have a question about something, they immediately ask if they can "check it out on the Internet." The impact of the Internet and Encarta seemed to have dramatically changed a traditionally "boring" activity. Research took on a whole new dimension, according to teachers, and students were learning more because of the time and interest they invested in accessing, reading, and processing information.

Not only did students *enjoy* using the Internet for research purposes, survey data suggested that they were skilled in doing so. When asked about their expertise in using search engines to find information on the web, 53 percent of students said they had enough experience so that they could effectively teach this skill, while 25 percent indicated that they could perform such a task without assistance from others (Figure 15).

Figure 15

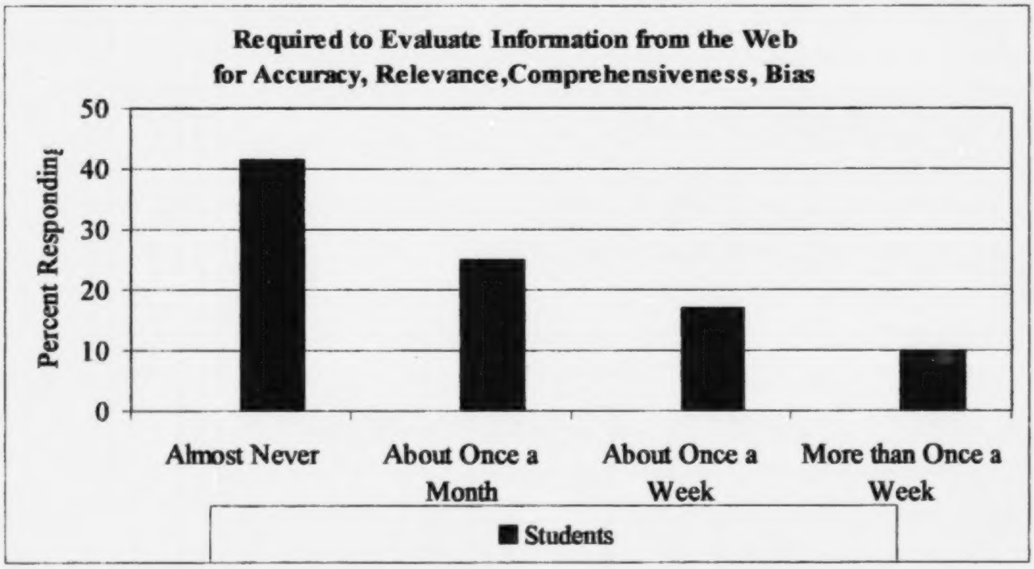


Teachers were nearly unanimous in their perceptions about the benefits of technology for motivating and enriching students' research efforts, as this selection from a journal indicates:

> *"...The power of primary sources. These sixth graders CAN read and understand the philosophy presented by such giants as Malcolm X and Marcus Garvey. They for sure have a better and deeper understanding of racial issues and different views this year thanks to the Internet!"*

Assessing Online Information. An interesting finding regarding the use of technology for research emerged from student survey data. Students in grade 6-12 were asked to respond to the following question: *"Considering all of your classes, how often do your teachers have you evaluate information found on the World Wide Web (for accuracy, relevance, comprehensiveness, bias, etc)?"* Responses indicated that students were rarely asked to do this. Of the students who answered the question, only 10 percent indicated that they evaluated online information more than once a week, while 41 percent stated that they almost never did so (Figure 16). This finding deserves the attention of teachers, given the extensive use of the Internet in the classroom.

Figure 16



Higher-Order Thinking and Problem-Solving Skills. In addition to motivation, teachers found that students' problem-solving skills were improved because of their technology experiences. Generally speaking, students were masterful at unraveling the intricacies of a particular program or application. They might, for example, discover the potential of Word Art for enhancing a report, or perhaps they would find useful tools in Excel to design more meaningful graphs.

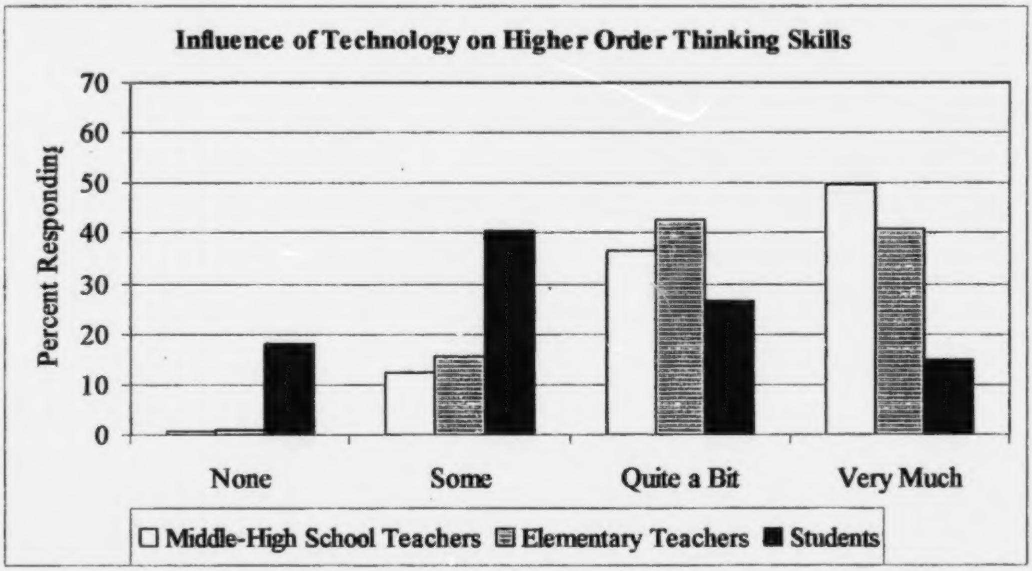
Students' higher-order thinking skills were sharpened when they had access to technology. Doing Internet searches, for example, required students to identify relevant and focused search terms. To do this they needed to think about relationships between specific words and concepts, about ways to limit a search, and about how to synthesize information. Teachers also shared examples of how students used sophisticated thinking skills to decide how best to present information, be it graphically using Excel, or visually using a Power Point presentation. Comments illustrate these perceptions:

> *"I believe the students are also learning differently, shifting from a "lock-step" text driven instruction, to an increase in "discovery learning." They are also increasing the use of problem solving strategies, such as when an attempt to get the information they need doesn't work, or the computer appears to have a mind of its own, they might "guess and check" their way through the problem."*

> *"They are also learning to apply the problem solving strategies they learn in math to the problems they encounter using the computers. (Logical reasoning, brainstorming and guess and check.)"*

Interestingly, when teacher and student perceptions were compared using survey data, teachers once again were more certain about the positive impact of technology on higher-order thinking skills than were students. Fifty percent of secondary teachers and 41 percent of elementary teachers agreed that their use of technology "very much" influenced them to involve students in activities that require higher order thinking skills. Of students, however, only 15 percent felt that higher-order thinking activities were an important part of technology-rich classrooms (Figure 17). It may be the case that students did not fully understand what higher-order thinking skills are, or maybe they could not relate the term to what was actually done in the classroom. In any case, there was a discrepancy in how student and teachers perceived this aspect of technology integration.

Figure 17



Comprehension. Not only did the availability of technology impact student motivation, thinking skills, research strategies, and writing, but it also influenced students' reading and math comprehension. The most common example of how technology integration affected mathematical understanding was related to data analysis and graphing. Students have always been required to gather and graph data, using pencil and paper, and more recently, calculators. With spreadsheet capabilities, however, students were able to quickly enter and analyze their data. Even more powerful, however, was the potential to present their information graphically. The process that students followed in selecting the most appropriate type of graph and explaining the findings to an audience seemed to give meaning to the data that was seldom seen when done with pencil, paper and calculator.

Journal reflections also suggested that reading ability and comprehension increased due to the addition of computers to the classroom. In cases where Accelerated Reader was used, teachers were convinced that students read *more*, and at *higher levels*, because they were so motivated to take comprehension tests on the computer. This was particularly true for younger children and those who might typically be classified as low readers. For older students, increases in reading ability were attributed primarily to the fact that students read so much more doing online research. In a few cases, teachers were able to compare this year's reading scores to those of previous classes, and found noticeable increases. This, of course, *may* be related to the technology, although it would be premature to assume a direct cause and effect relationship. Teachers commented that:

> *"The evidence of increased learning will be evident when we get our Accelerated Reader testing scores back next week. I know that there will be outstanding growth shown because of the computers and the motivation that they provide to complete a book and take that test!"*
>
> *"With the addition of the computers, having to learn about temperatures and graphing has taken on a totally different meaning. The students have ownership in their own learning. They hold themselves accountable for finding out what they need to know to fill out their graphs. They actual have a better understanding of what temperature is, what causes it, why it's not always the same temperature in towns that are in the same area. I feel that this group of students really has a solid foundation about what these numbers mean and how to plot them on the Excel graph." (2nd grade)*
>
> *"As I mentioned earlier, the students are working independently on both our* A.R. *reading programs, with little help needed from me, except to monitor activity. Both programs provided data to share with parents and students at our last conferences. The news was great! All my students, but one, had significantly improved scores and reading levels from the beginning of the school year."*

"The students were actively delving into books and other research materials in order to find the information they needed to put into their presentation."

> *"I just received the results of our ITBS testing yesterday. In looking over the scores I noticed some key things. I have never seen scores this high on the ITBS, and only one of my students is performing below where he/she would be expected to perform. That student happened to join my classroom one week prior to the test. Many of my students are out-performing their expected achievement level, and the areas in which they are doing this most often are math problems, and reading comprehension. This could be due to our Everyday Mathematics curriculum, and the use of Accelerated Reader. But I also think that both of those areas are areas in which the students are required to think and process information, and I think it is possible that the technology, in addition to the curriculum has given them a boost in that."*

> *"While I do not have concrete evidence, I am convinced that my students will remember what they create on a PowerPoint virtual museum far longer than what they read about in a textbook. The students were actively delving into books and other research materials in order to find the information they needed to put into their presentation."*

Special Needs Students. Integrating technology into the curriculum appears to have had a positive impact on special needs students. For those kids who found it difficult to focus, who had limited fine motor skills, who had specific learning deficits, or whose behavior interfered with day-to-day classroom activities, technology seemed to provide both the motivation and the vehicle to improve their performance. Teachers shared numerous examples of special needs students who blossomed during the year, in large part because of their access to technology. For ADD and ADHD students, computers proved to be the tool that led to increased time on task. Students who struggled with pencil and paper activities such as writing and drawing found that various computer applications allowed them to express themselves with much less effort. And finally, there were cases where students who were unaccepted by their peers for various reasons who proved to be very capable users of technology. The fact that they were skilled "technicians" seemed to pave the way for collaborative experiences.

Teachers shared numerous examples of special needs students who blossomed during the year, in large part because of their access to technology.

> *"An interesting phenomenon I've noticed is that several of my lower achieving students have become the "experts" in some area of technology. Their peers look at them in a more positive light because they have needed skills. One particular boy who was seen as a bully and whose first language is not English has really risen in his peers' estimation as a result of his skills in Power Point and his artistic design ability."*

> *"I have some [students] who last year seemed to make little or no progress. Here is one student as an example. This boy never wrote more*

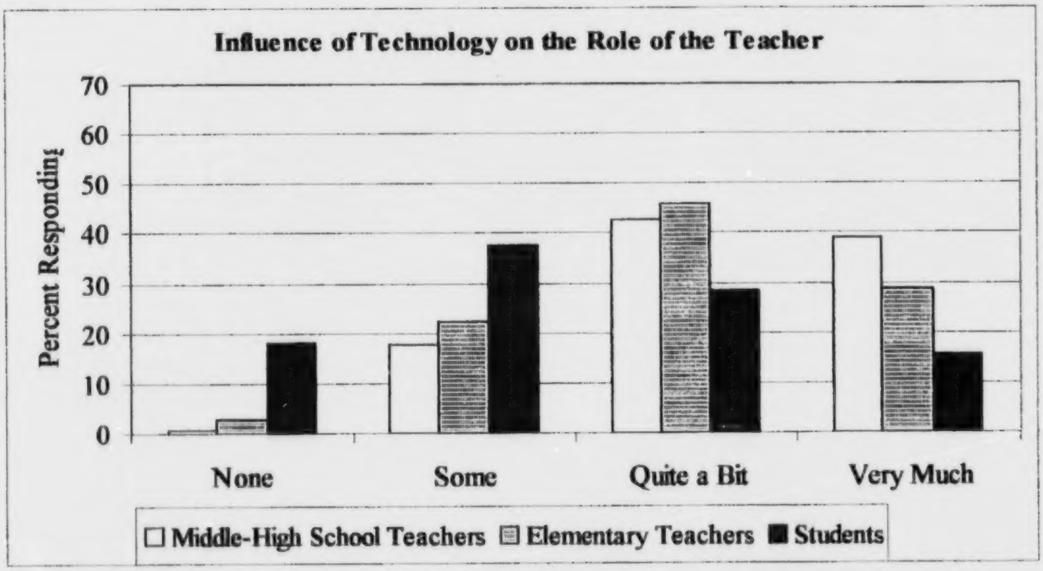
> *that a sentence or two. He was not motivated to do so. I believe that through conversations with him he was so embarrassed with his spelling he didn't want other to know he was in his words "Stupid." The computer as a writing tool for him is salvation. He sees that he can type and then work with the spell checker and none of the others are the wiser. Further, he is now writing by hand great stories. His spelling is not improved much (YET!) but his confidence is! I had little hope for his last year, it just seemed that nothing we could do would get him going, now nothing I can do will hold him back! That is the amazing power of the added technologies into my classroom. His success in 8 to 10 years will be my proof that we did the right thing."*

Effects of the Teacher Leadership Project on Teaching

When TLP participants were asked if the integration of technology had changed their teaching, they responded with an emphatic "yes." Role change emerged as a theme in a number of first-year journal responses and in nearly every response from second-year teachers. As they become more entrenched in the integration process, teachers realized that infusing technology effectively and efficiently required a change in practice, if not in philosophy, about teaching and learning. First and second-year responses indicated that both the role of the teacher, as well as the relationship between teacher and student changed rather dramatically when technology became a classroom tool. First year TLP teachers reported that their classrooms were much more student-oriented, and that they functioned as a guide and facilitator of learning rather than as a director of learning. Responses from second year teachers were similar, but included an added dimension. Noting the benefits of working side-by-side with students in learning and teaching, they also discussed the necessity of becoming skillful designers of curriculum and the time involved in doing so. And while they firmly believed that partnering with students in the teaching and learning process created a powerful and positive classroom dynamic, they also found that it required much more up-front time in developing and preparing lessons. Student-centered learning, according to these teachers, did not necessarily mean *discovery* learning. Rather it required teachers to be very thoughtful and intentional in the lessons they design, both in terms of content and in terms of utilizing technology. The results were worth it, most certainly, as students became collaborative, independent learners.

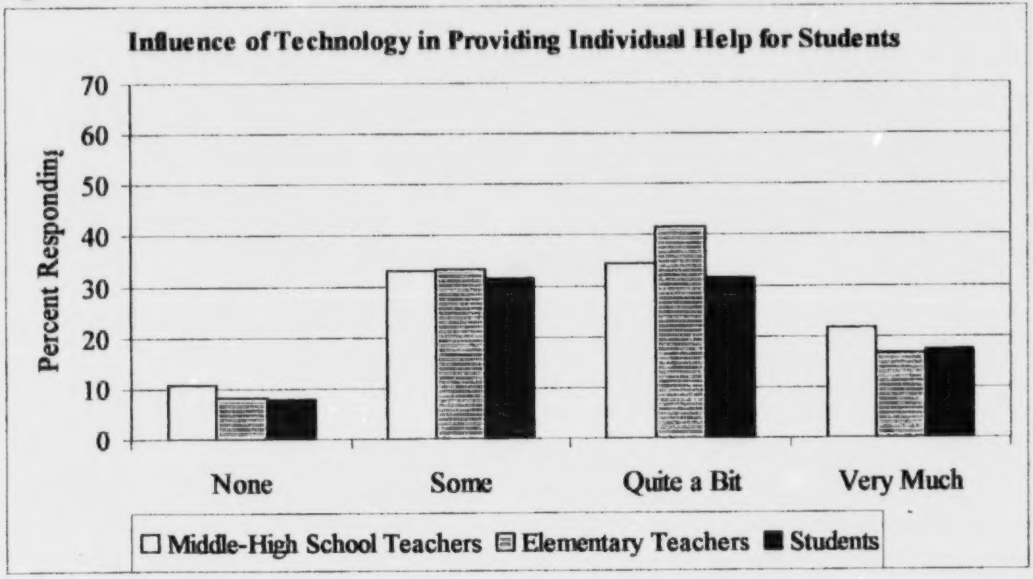
Survey data supported journal reflections from teachers. When asked about the degree to which technology influenced their teaching role, a majority responded either "quite a bit" or "very much" (Figure 18). Student perceptions differed from those of their teachers. Only 16 percent of students indicated that the role of the teacher seems to change in technology-rich classrooms.

Figure 18



Finally, survey data gave some insight into the degree to which technology allowed teachers to provide extra help to students. Most teachers felt they were better able to offer extra assistance when technology was an integral part of the classroom routine (Figure 19). Students were less likely to find this to be true.

Figure 19



"I continue to feel that the students are learning to be more objective and critical learners. This may be more due to refocusing and revising my philosophy and concentrating more on outcomes than the fact there are computers/technology in the classroom."

"As a teacher it seems like I do a lot more upfront planning to get a technology integrated unit going....but then MUCH more of the student learning is in their hands. They are able to better access and then communicate what they know using various mediums. I feel like more of a curriculum planner and then guide and tutor."

"I 'm finding that I am changing my approach to teaching. I feel that my class is more a learning community and that I am learning as much as the students. In one of my classes in particular, I feel that I am a guide for some very exciting learning opportunities. It's really fun!"

"When one student is stuck, another student is often able to explain what to do, freeing the teacher to work one-on-one as needed with other students. The teacher is readily the "guide on the side" vs. the "sage on the stage" exactly as we learned in our methods classes."

Role change emerged as a theme in a number of first-year journal responses and in nearly every response from second-year teachers. As they become more entrenched in the integration process, teachers realized that infusing technology effectively and efficiently required a change in practice, if not in philosophy, about teaching and learning.

"I have relied on technology to become the conveyor of information rather than being that myself. I am convinced that 25 students doing research can learn more than I could convey with my one voice. I find myself quite often having to help students evaluate and synthesize information into thematic presentations. It moves their thinking beyond simple recall of facts. When students can choose their own inquiries with expected guidelines for reporting to the class, they are motivated to work hard."

"I find that I am more of a curricular designer than previously. I'm redesigning my curriculum into thematic units with essential questions that students are responsible for learning."

"I find myself doing less of the instruction and putting more of the role of learning on the students. I feel that I am able to focus more on working with the students rather than "feeding the students." My instruction has become more project based and has been focusing more on the "less is

more" approach. I have found myself covering less content more deeply and the students learning more rather than covering more. With the technology I have found it easier to step out of the direct instructor role and more into an assistant in learning role. I also find myself planning much deeper on lessons to ensure they are successful and not just a waste of time. As a result of the training, I have also begun to recognize some of my cool activities are just cool activities rather than sound educational processes. I find myself looking more at the big learning ideas and less at little pieces."

Impact of the Teacher Leadership Project on the School

Second year teachers were asked what impact their participation in the TLP had had on the school. Responses indicated that in nearly half of the schools, the use of technology had spread.

A stated goal of the Teacher leadership Project is to develop instructional leaders who not only impact teaching and learning at the classroom level, but who also provide leadership at a building level. To this end, second year teachers were asked what impact their participation in the TLP had had on the school. Responses indicated that in nearly half of the schools, the use of technology had spread. In some cases, this was directly related to the TLP, as participating teachers were able to use their experience and knowledge to further a thoughtful technology agenda. In other cases, increased use of technology was due to more students searching out and using computers, either in lab settings or in teachers' rooms. A few teachers noted that while computers across the school weren't necessarily being used more often, they were being used differently; that is, use was not limited to word processing and games. This seemed to be related to in-service opportunities provided by TLP teachers, which equipped and encouraged non-technology teachers to extend their practices. For some teachers, the mere fact that the building started to address technology (in the form of a technology plan, perhaps) was a significant move forward. On the other hand, some teachers commented that nothing had changed. Reasons varied, but most often this was due to a staff of older teachers who had neither the desire nor the time to make such a dramatic change toward the end of a career. In a few cases, teachers believed that movement relative to technology was unlikely to happen until a new administration was seated.

Journal responses suggested that several factors played a part in whether or not a TLP teacher could influence the level and quality of technology integration in a school. Financial resources, philosophy of the staff, and willingness of teachers to learn how to use technology all influenced the degree to which a school was changed. As well, TLP teachers themselves differed in how they approached their leadership directive. Some were obviously interested in helping others "catch the vision" of technology integration, while others were more concerned with directing change at the classroom level.

> *"My school has changed in subtle ways due to my involvement in TLP. First of all, there is simply less stress on our computers/network since I(and other TLP teachers) have this wonderful equipment. Secondly, other teachers were inspired to go for TLP grants-and many of them have been successful. Thirdly, other teachers are asking me for advice, suggestions and in some cases mirroring what my team partner and I do with technology in our classroom. Finally, the level of technological expertise has been raised significantly in our building-the rising tide has lifted all the boats."*

> *"I have trained our entire science department on integrating technology (all science classrooms have a 4 to 1 ration) into the grade level curriculum- focusing on PowerPoint, Excel, and SchoolKit. We were able to hold the District accountable to their promise of computers in the science rooms because we could guarantee that the hardware would not just sit there- that I could train all science teachers how to use the computers to increase student learning."*

Summary

Both journal responses and survey data offered strong evidence to suggest that student learning was positively impacted when technology was thoughtfully and purposefully integrated into the curriculum. Teachers believe that attitudes, process skills, products, and comprehension were all increased, to varying degrees, when students were taught to use technology. Student motivation is by far the most positive outcome discussed by TLP teachers. Motivation to be at school, to participate in and complete lessons, to go beyond the minimum requirements, and most importantly, to *learn,* can be attributed to computers, according to TLP teachers. And motivation, according to Robert Sternberg, "is perhaps the indispensable element needed for school success. Without it, the student never even tries to learn" (1998, p.17). Indeed, Sternberg proposed a model in which "motivation drives metacognitive skills, which in turn activate learning and thinking skills, which then provide feedback to the metacognitive skills, enabling one's level of expertise to increase" (p. 17). And so while motivation may appear on the surface to merely be students' enthusiastic response to having and using lots of technology, it may in fact be a key to transforming their educational experience.

Teachers documented other positive outcomes resulting from technology integration. Collaborative skills, problem-solving abilities, interest in school, independence, time-on-task, quality of final products, and amount of work completed were all areas that improved when technology was infused into the curriculum. Communication, reading, and conceptual understanding were also developed when students had the opportunity to use technology as one of their learning tools. Special needs students were particularly motivated by the availability of technology.

Although few in number, there were also those teachers who found little benefit from implementing a technology-integrated curriculum. Aside from the obvious development of computer literacy skills, they found few advantages to having students use computers to complete lessons. The fact that they found no academic benefit, along with the additional time and effort required to teach with technology was enough to convince some teachers that computers are expensive additions to the classroom that do not qualitatively change student learning.

> *"I don't want to beat the time issue to death, but the presentation of information to class using technology and the showing of what has been learned by using technology takes a whole lot longer. It has not been demonstrated to me that the assessment of the content is any better using technology. Yes, there are other types of learning going on while researching and preparing a technology presentation. I have not assessed that and I really don't know how. But, in my experience, the learning of concepts and facts is not any better using technology...I was not impressed with the written reports. Using the same information, I see much better organization and logical sequencing on a Powerpoint presentation than I do on a written report. I realize that written reports are done individually and Powerpoints are mostly done using group effort, but each person is involved in the development of the presentation and you would think that the organization of it could carry over. I suppose I should better try to make that connection."*

> *"I do not see how their general learning has been enhanced by technology in the classroom. They do enjoy the computers and are excited about everything we do. They have learned a lot about using computers, which is important in this day and age. They are becoming more confident about their technology knowledge which is fun to see. It's great to see them help each other when there's a problem."*

All in all, however, both qualitative and quantitative data indicated that changes are indeed taking place in the classroom, such that students are much more motivated to learn, are more responsible and interested in their own learning, and are developing both technical and academic skills that have the potential to transform their future educational experiences. Evidence from teachers suggests that technology *does* lead to a transformation of teaching and learning in ways that have been proposed by researchers. That is, "Our understanding of human learning has....evolved based on a wealth of evidence collected over a wide range of different domains and media from which a process based on the passive assimilation of isolated facts to one in which the learner actively formulates and tests hypotheses about the world, adapting, elaborating, and refining internal models that are often highly procedural in nature" (Shaw &

"Being awarded this grant has brought about great changes in my planning and implementation of lessons. I have become a better teacher, and the real winners are my students."

President's Committee of Advisors on Science and Technology, 1998). And there are certain types of environments that facilitate this type of learning: "These new learning opportunities should take place in learning environments that are student centered, knowledge centered, assessment centered, and community centered…" (Bransford, et al., p. xvi).

The following two selections from teacher journals seemed to capture what a majority of TLP teachers found:

> *"This last question I always find the hardest to answer, but just the time spent reflecting on it each month is perhaps one of the most valuable things I have done as a participant in this program. If I am not seeing evidence of learning, then why bother? (And honestly, at first these new 'tools' can really be a bother)…Still, after all is said and done for this year I know that because of the addition to my classroom of computers as tools, and because of my participation in the TLP training, I have made major leaps in my own learning and understanding of how to incorporate technology to enhance students' learning. I am still just seeing the tip of the iceberg in terms of what I have actually been able to do in my first year, but I have been exposed to the Mt. Everest of possibilities! I know of online resources and offline resource people. I know of skills and applications. I know of essential questions & rubrics. I know I have changed the way I approach planning and teaching.*
>
> *I know my students also are just at the beginning stages of becoming fluent users of technology, but there is so much more they can do independently today than the day we first plugged the computers in. Their confidence has grown, they enjoy the project learning activities, and already take for granted that they can find the answers to their questions and explore the universe with a click of a mouse."*

> *"My students are feeling confident and successful as a result of using technology this year. They have learned more, in greater depth, in the same amount of time. I know this because of test results, quality of projects, and the things that they remember from earlier in the year. Being awarded this grant has brought about great changes in my planning and implementation of lessons. I have become a better teacher, and the real winners are my students."*

Evaluation Question 4: *What percentage of TLP teachers can be categorized as "technology integrated?"*

The primary goal of the Teacher Leadership Project is to provide K-12 classroom teachers with the equipment and training needed to integrate technology into the curriculum. This goal is noteworthy in that much of the computer technology that has been placed in schools in the past twenty years has been provided with little or no training on how to use it effectively and efficiently. As the ratio of students to computers continues to decrease, and the sophistication of technology available to teachers and students increases, there is an even greater need for teachers and students to learn how to use the computers in meaningful ways. The TLP has focused on this need for the past four years, and one component of the evaluation was to determine the extent to which teachers have learned to use the technology productively. To help identify patterns, degree, and scope of integration efforts, the following two criteria were applied.

- Is the technology a seamless and natural component of the lesson?
- Are the students generally focused on *learning* or on the *technology*?

As the ratio of students to computers continues to decrease, and the sophistication of technology available to teachers and students increases, there is an even greater need for teachers and students to learn how to use the computers in meaningful ways.

Taken together, journal reflections and survey data indicated that a majority of TLP teachers had, by the end of their first year in the program, learned how to integrate technology into the curriculum with relative success. The degree to which this happened during the school day varied, however. Efforts to infuse technology occurred more often and seem to be more natural with projects that utilized word processing and electronic references. Survey data supported this finding. Word processing, web access, and presentation software applications were used most often and most effectively to integrate technology into the curriculum, both for elementary and secondary teachers.

Technology is a Seamless and Natural Component of the Lesson

Probably the greatest difference in responses from first and second-year TLP participants was found here. While first-year teachers worked very hard to develop and deliver meaningful lessons, it was not unusual for them to address technology integration from a quantitative perspective; that is, how much or how often they were able to use the computers. One of the themes to emerge from first year journals was the sense of guilt that teachers felt when the computers were not being used, or when they were not used "enough." In some cases this was because of distractions such as conferences, holidays, testing, assemblies, and the like. In any case, whether it was stated or not, first year teachers as a group seemed obliged to have the computers in use all day, every day.

Second-year teachers, on the other hand, seemed to adopt a more balanced perspective on integration. They commented that while technology was not used as much, it *was* used more effectively. Time and experience allowed them to step back and reflect on the big picture, which allowed them to concentrate their efforts on lessons that would maximize the potential of the equipment. Some comments from second year teachers make the point:

> *"My views on integrating technology into the curriculum have changed somewhat since I started with the TLP. I now tend to pick and choose when it will be a best fit for integration, instead of doing it all of the time and just sort of "sliding it in." I feel like I use my computers less BUT the time spend on them is more directly related to student learning- in fact, the activities they do on the computers could not be accomplished without them with the same high knowledge learning."*

> *"My views on integrating technology into the curriculum are to use the technology where it is appropriate and comfortable. Last year, I tried to integrate the technology into everything that I did. This year, I feel that it is OK not to use the technology all of the time. There are times it isn't appropriate, like during a science experiment. I have also found out that not all students want to do their daily work on the computer. I let those that want to, use the computers for daily work. I still have certain projects that are completed on the computer and all students at one time or another have to try the assignment on the computer."*

> *"Last year, I felt that I needed to use technology in virtually every lesson. I felt quite a bit of pressure to do this from some of the other teachers in my building. However this year I am trying to integrate technology only when it is the best way for my students to learn."*

Focus is on Learning, not on Technology

Certainly learning is the intended goal in all lessons that teachers develop for their students. The degree to which this goal is realized differs based on length of time in the program and subject area. First-year teachers must necessarily allow for "learning time," both for themselves and their students. Some teachers employ a "Just in Time" philosophy to do this, where the learning rather than the technology is the outcome. This necessitates a certain amount of "letting go" where teachers let their students jump in and explore. The majority of new TLP teachers, on the other hand, begin their efforts by choosing lessons that will allow direct teaching of the technology. For example, beginning use of Excel found students taking attendance, recording lunch count, and other such maintenance activities. In other cases, students used the Internet to track and record the weather. As teachers got more comfortable with a specific application, the focus shifted from technology to learning: using Excel for constructing math graphs, or using the Internet to gather information for reports.

> *"Some applications still scare me. Then once I get started it's not as difficult as I thought. I am afraid to get into some projects because I still feel like I will loose teaching time... I still need a little paradigm shift."*

> *"I have chosen the "learn as you go" technique and I am absolutely amazed at how fast these youngsters pick up on the skills. The saving files, moving objects around and formatting their work came so easy to most of the class."*

> *"It never ceases to amaze me how the most difficult part of using technology in the classroom is the 'jumping in' part. I stress about how it might work, how best to structure groups for good flow and what it will look like when it's a finished project. Lo and behold, each project I try, is more successful than I could have imagined, thanks to School kit projects . . . The lesson?...just jump in and the kids will figure out the rest. . . . What I will do differently this month . . . jump in once a week with something new from SchoolKit... Wish me luck............"*

> *"I am suddenly over the hump where technology is concerned. Our classroom computers are finally a seamless part of our daily work and culminating activities!"*

> *"Just a note in general. I certainly feel as if I am making more headway now than I was two months ago. For each step you take it is like you build up a foundation that allows you to expand more rapidly. Spiral learning at its best. I can trust a new level of confidence in my understanding and use of the programs."*

Clearly, time and experience lead to more sophisticated integration efforts. Reflections from teachers at the end of their first year, and from second-year participants, indicated that learning does indeed become the goal of integrated lessons. Computers are viewed, and used, as just one of many tools to support student learning.

> *"I have learned to keep a balance in my teaching. When I first used the computers last year, I wanted to do everything on the computers! In my excitement I seemed to overlook technology usage as a "tool" – not as an end in itself."*

Reflections from teachers at the end of their first year, and from second-year participants, indicated that learning does indeed become the goal of integrated lessons. Computers are viewed, and used, as just one of many tools to support student learning.

> *"I came to realize that some things worked better on the computers, while others did not. My students missed working in their Writer's Notebooks*

> *where they could sketch, revise, and carry their stories home with them. Some students needed to make projects on mural sized paper and build "castles" out of cardboard boxes. This year I have learned to achieve a balance in my classroom – providing a better environment for different learning styles. I also find that I am doing less teaching of application software and more "just in time" teaching. I didn't really get that concept last year!"*

Justifiable Cost-Benefit Ratio

One of the more interesting findings to emerge from journal reflections as the year progressed had to do with teacher reflections on the "costs" of using technology when compared to the benefits. While the number of teachers who shared such information was relatively small, it was nevertheless encouraging to know that this type of thoughtful analysis was occurring. An example from a first-year teacher follows:

> *"In some ways I think I have decreased our usage! I'm questioning more whether or not using the technology increases our productivity, or the learning of the students, and if not, then I'm not using it. An example would be an activity we did where I typed a passage from their reading book, but I took out all the punctuation and capitals, and I misspelled many of the words. (This in itself was a chore due to Word trying to autocorrect me.) I thought about just putting the file on the server, and having the kids look for the mistakes using their computers. However, my students have recently figured out that they can fix spelling errors by right-clicking the words (I didn't teach that... one learned it and taught the rest!), and Word underlines with red and green all the errors I made on purpose. I would have had to turn that off on all the computers, and then turn it back on for them so they could use that tool when word processing. It just didn't seem worth the extra time."*

Survey Results

Results of survey data from the TAGLIT provided interesting information about the degree to which teachers and students use and learn with technology. Two-thirds of both elementary and secondary teachers felt that while they had not achieved seamless integration, they had, nevertheless made significant progress (Figure 20). Approximately one-fifth of the teachers indicated that their technology integration efforts were natural and powerful, while slightly less felt that they were still at a beginning stage in effectively using the technology.

Word Processing. Data also revealed the level of integration teachers had reached in terms of specific applications. Responses indicated that teachers were most successful at integrating lessons using word processing, as shown in Figure 21. Two-thirds of both elementary and secondary teachers indicated that they made a conscious effort to include and "effectively integrate" word processing technology in their lessons. A much smaller percentage felt that they had reached a level of "natural and powerful" integration. Students, interestingly, were more convinced about the importance of word processing in the classroom.

Figure 20

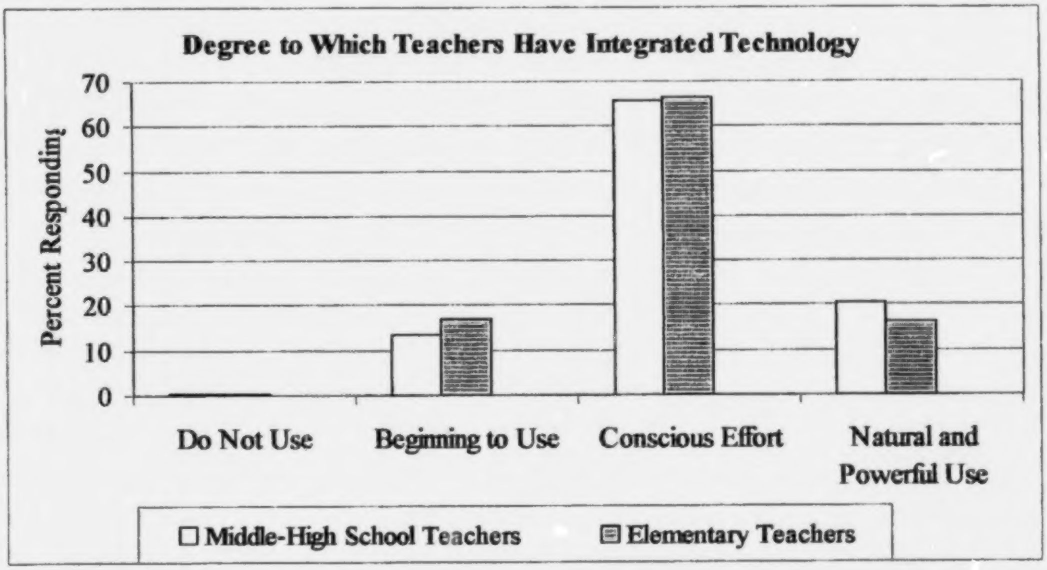
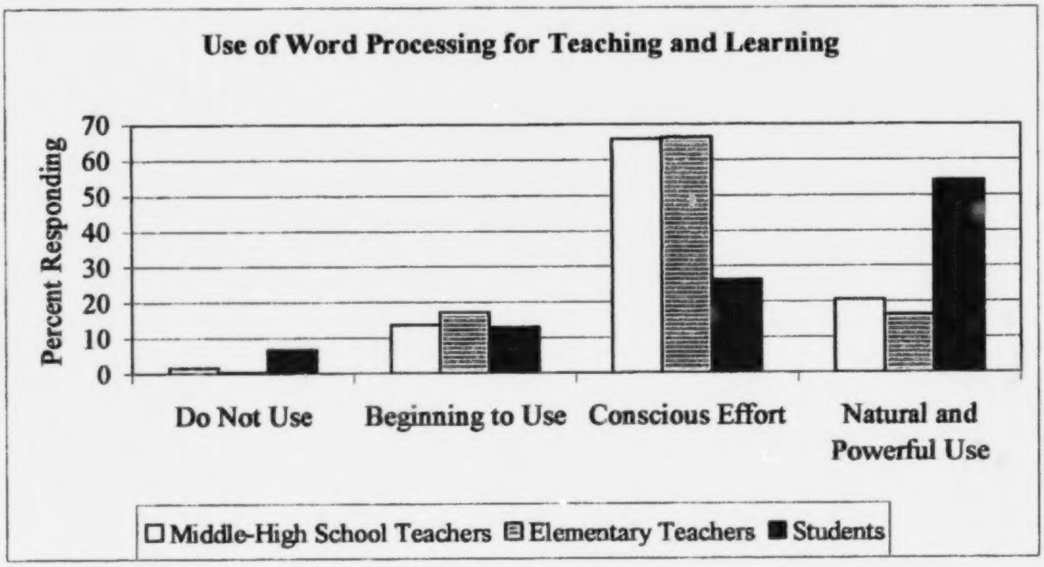


Figure 21



Electronic References. Results showed that teachers were quite successful in their efforts to integrate electronic references, such as the Internet and CD ROM, into their lessons (Figures 22 and 23). Secondary teachers in particular found ways to naturally include online resources for information access.

Figure 22

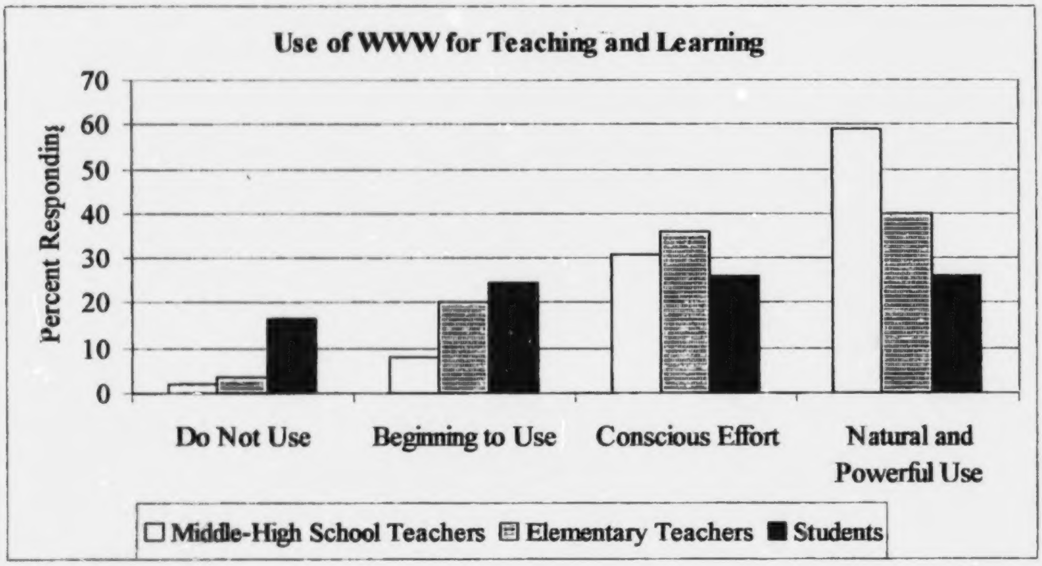
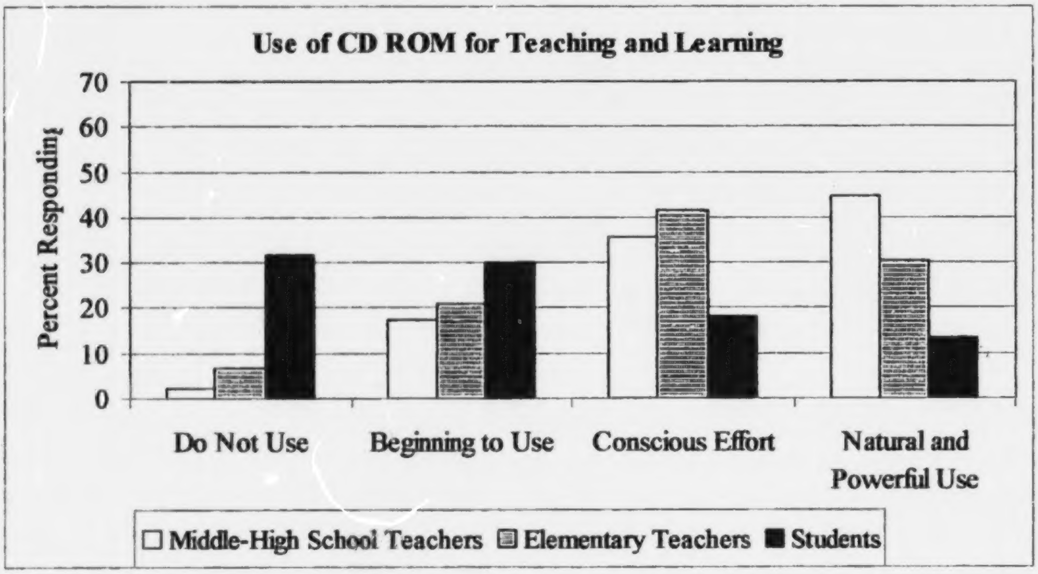
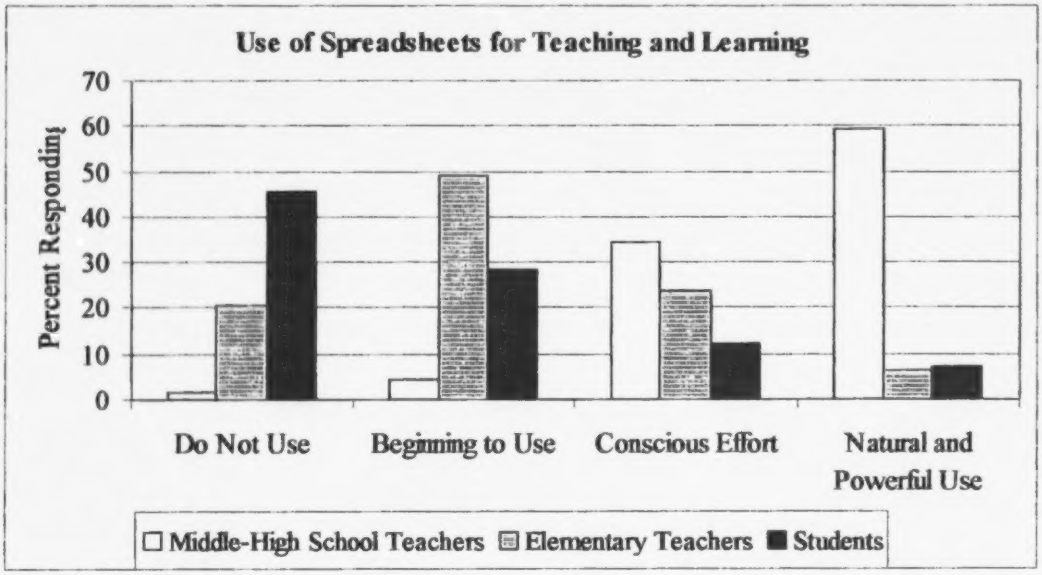


Table 23



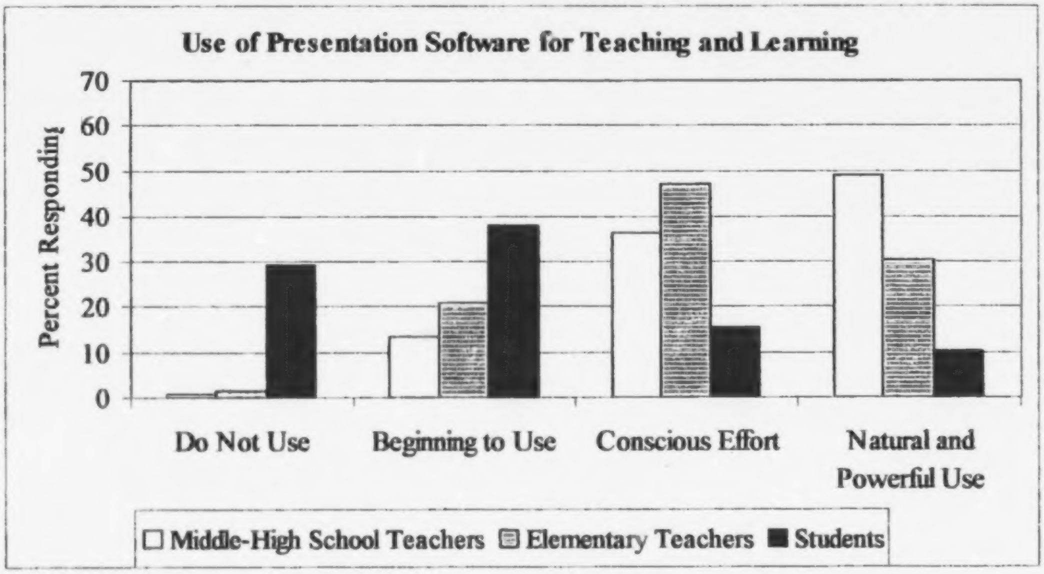
Spreadsheets. While nearly sixty percent of secondary teachers reported that they were able to seamlessly integrate the use of spreadsheets into the curriculum, only 6 percent of elementary teachers had reached that level (Figure 24). Rather, elementary teachers were more likely to categorize themselves as "beginners" in this area. More interesting, however, was the perception of middle and high school students. While their teachers felt that spreadsheets were "naturally and powerfully" used in the teaching and learning process, only 7 percent of students appeared to find this application to be a meaningful part of their work. Perhaps spreadsheets were used primarily for teaching, rather than for student work, which could account for the considerable difference in perception. On the other hand, teachers may have overestimated the degree to which spreadsheets were actually used on a day-to-day basis.

Figure 24



Presentation Software. The degree to which teachers used presentation software, such as Power Point was somewhat surprising when compared to responses from their journals. Survey data suggested that while a majority (49 percent) of secondary teachers used such applications seamlessly, only 30 percent of elementary teachers had reached this point (Figure 25). This was interesting, since journal reflections seemed to indicate that presentation software, along with word processing and online reference sources were widely and powerfully used. Possibly teachers realized that even though presentation software was used *frequently* with students, it was not yet seamlessly integrated, and thus they qualified their responses on the survey. While the results regarding elementary teachers were surprising, even more surprising was the degree to which student and teacher perceptions differed. Again, journal reflections from teachers implied that they had students used Power Point software frequently and expertly. It was therefore interesting that such a small percentage of students perceived this to be the case. The most likely explanation seems to be that students were not familiar with the terminology used in the survey ("presentation software"), and thus did not equate it with Power Point. If this is *not* the case, it is difficult to explain the discrepancy.

Figure 25

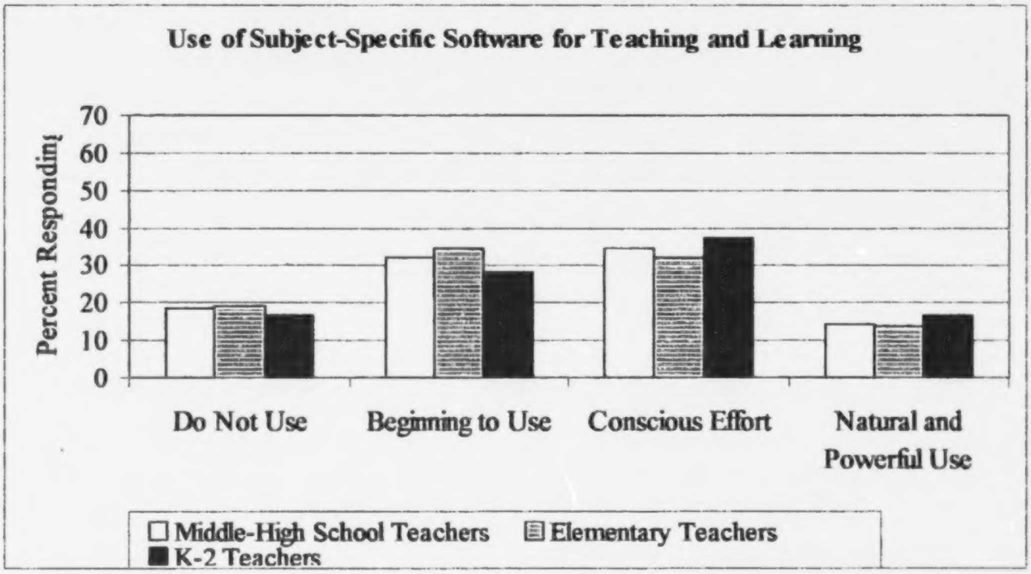


Subject-Specific Software. Teachers who participate in the Teacher Leadership Project are given hardware to reach a 4:1 ratio, as well as the Office Suite, Encarta, and access to SchoolKit Rex. Some teachers chose to supplement their electronic curriculum with various other programs, both to address particular objectives, and for enrichment experiences. With an ever-increasing selection of subject-specific software available, the degree to which teachers used it in integrating the curriculum is worth noting. Most teachers, regardless of grade level, reported their use of subject-specific software to be at either a "beginning" or "conscious effort" stage (Figure 26). Relatively few considered their use of such programs to be seamless. Interestingly, K-2 teachers' use of subject-specific software was slightly more than that of higher grade-level teachers. This may be due to the fact that, according to journals and observations, primary teachers tended to use skill development software (Reader Rabbit, Math Blasters) to meet their students' developmental needs. Programs that allowed children to practice letter and number recognition, sequencing, and basic math computation were used to reinforce skills taught in class. At the secondary level, math teachers in particular found subject-specific software such as Geometer's Sketchpad, to be useful.

> *"Jumpstart Kindergarten seems to be a great program with several pre-reading activities. Jumpstart Math also seems to be a winner with many appropriate counting and readiness activities."*

> *"In Science we have been studying the human body. I have made a few lessons in which students use a website and then answer questions based upon facts they can retrieve from the site. As a whole class presentation we used a CD ROM called ADAM, The INSIDE STORY. We looked at the circulatory system this last month. It allowed us to look at the system with 3-D views that you can rotate on an axis. It also contains short videos of beating hearts, bypass surgery and blot clotting. We took a quiz at the end of the circulatory section and they did very well."*

Figure 26



Future Direction. The TLP provides intensive training to new participants in how to effectively integrate technology into the curriculum. This includes five days during the summer, and three follow-up sessions over the course of the school year. Teacher training was modified mid-year during 2000-2001, and it would not be surprising if this change subsequently results in more focused, effective, and efficient integration of technology. Rather than training teachers to approach technology integration through curriculum projects, as has been done in previous years, the direction has shifted and is now focused on the "Understanding by Design" work of Wiggins and McTighe (1998). While projects and theme-based units are still an essential component of technology integration, teachers are now being taught how to use a curriculum framework, based on three basic steps (Backward Design):

1. identify desired results
2. identify acceptable evidence
3. plan instruction and experiences

Essential questions are identified for a given subject or curriculum, and are used to direct and plan instruction. Engaging, relevant teaching and learning activities are then designed to answer these questions. Technology is used to help accomplish the desired results, which are identified at the outset of instruction.

While teachers were not asked specifically to discuss their success with, or feelings about the curriculum framework model, some did take the opportunity to give feedback in their journals following regional training sessions. This initial feedback suggests that the model will be extremely useful to teachers in developing curriculum that not only meets students' educational needs, but also incorporates technology naturally and meaningfully.

> *"After reading about the Middle Ages in our social studies book, we decided that we were missing a sense of what it felt like to be alive during those times. So our essential research question is "What was it really like living in the Middle Ages?" This worked in perfectly with the recent TLP emphasis on Understanding by Design. Students are using the research model (we are using the U of W's Big Six) to become living beings from the year 1250. Each student is in a role and digging out information in Encarta, trade books, and on-line resources to answer questions each has developed. We used the software Inspiration to map out our questions and record our discoveries in the note's option. Today students printed out the outline version of their research. Wow! This will now be used to develop a plan for what they will show and tell as we transform the library into the kingdom of PineCrestia. There is a lot of excitement. We are using technology authentically. I started a pathfinder... a guide to resources which included Internet sites... and I was pleased to see students treat it as a growing tool by adding sites they thought were too good to miss. Yes!"*

> *"I so enjoyed the last Regional Workshop and the work we did with the "Understanding By Design" materials. That exercise really made a connection for me and helped me to better understand the main goal of the TLP program. It helped me feel that I was doing more than I realized in this direction, but it also helped me to see how much better I can be."*

Summary

Given the results of journal analyses and survey data, it appears that a majority of TLP participants have reached a respectable level of integration. Teachers try very hard to design lessons that utilize the technology for learning, and their efforts seem to be much more effective as they finish the first year, and especially during the second year. Across application and grade levels, approximately 30 percent of the teachers appeared to have reached a level where technology use is both seamless and powerful. Effective integration happened earlier with applications such as Word, Power Point, and the

Internet, whereas success comes more slowly with Excel, Draw, and multimedia programs.

The direction being taken by TLP leadership in the curriculum development training provided to teachers is a positive step. Initial feedback from teachers is enthusiastic, and it may be the case that such intentional and focused planning will help teachers concentrate their efforts on student learning rather than on technology.

Evaluation Question 5: *What leadership activities have the teachers performed during the year?*

One of the primary goals of the Teacher Leadership Project is to encourage participating teachers to share their training, knowledge, and skills with colleagues in and beyond their buildings. To this end, opportunities are provided at regional training sessions for teachers to make presentations and share lessons with their colleagues. Teachers are also encouraged to offer classes, in-services, and help-desks for their schools and districts. To identify the extent to which teachers actually did take on leadership responsibilities, they were asked to respond to a journal question addressing this topic. Specifically, they were asked, *"In what, if any, leadership or sharing activities have you and/or your students been involved this year?"* Responses indicated that nearly all participants, both first and second year, shared their skills and resources at some level, including technical support, program and skill classes for both the building and district personnel, computer club activities, parent/family training, ESD classes, college classes, professional conference presentations, and community classes. Teachers also involved their students in sharing, often by providing technical support at the building level.

Leadership Activities

Teachers spent a great deal of time providing technical assistance to their immediate colleagues. Most teachers, simply because of their selection into the Teacher Leadership Project, were perceived as "technical experts" in their buildings, and were often approached by other teachers for assistance in answering technology-related questions or in solving any number of computer-related glitches. They might, for example, be asked to help find or use subject-specific programs, to troubleshoot printer malfunctions, or to help save files. While being recognized for their technical expertise was empowering to a certain degree, teachers also felt pressed for time and sometimes found that the requests for assistance became overwhelming. In any case, teachers frequently expressed amazement at how much they actually *were* able to help, given their relatively limited experience with computers. In most cases, despite being stretched for time, they were willing to assist colleagues in any way they were able.

In addition to providing technical support to fellow teachers, TLP participants also taught technology-related classes in their buildings and districts. Offered on LID days, after school, or as mini-lessons during staff meetings, these classes often involved teaching specific programs such as Word, Power Point, and Excel, as well as SchoolKit. Sometimes teachers made the decision about what to offer, while in other cases the topic was determined by expressed needs of the staff or principal. Response to such classes was generally positive, although in some cases the audience had either little interest or limited equipment (or both) and felt the time could have been better used in other ways. Also, staff members were often discouraged, after seeing the potential of SchoolKit, to find that it was not compatible with Macs.

Nearly all participants, both first and second year, shared their skills and resources at some level, including technical support, program and skill classes for both the building and district personnel, computer club activities, parent/family training, ESD classes, college classes, professional conference presentations, and community classes.

Besides offering classes, TLP participants frequently opened up their classrooms during, before, and after school to other teachers (and students) to provide less structured training time. They might offer to assist their colleagues in learning to do focused Internet searches, to use e-mail, or to use the digital camera. They facilitated after-school computer clubs and computer projects (such as school newspapers) for students, as well as Technology Nights for families. These were opportunities for parents to see the types of lessons and projects their students completed in a technology-integrated environment. TLP teachers often did the planning and organization for school technology nights. Finally, TLP teachers shared lessons and strategies with their colleagues at regional TLP training sessions held during the school year. All in all, TLP teachers made sincere efforts to share their skills and their student's work through classes, small-group sessions, and in-services.

TLP teachers and their students were active in making presentations to their School Boards and Parent-Teacher meetings, usually to demonstrate student work and the potential of a computer-rich environment. They also opened their classrooms to members of the school board, district office administrators, and others interested in seeing a technology-integrated classroom "in action." In cases where districts were facing bond and levy elections, TLP teachers involved themselves in various activities to encourage voter turnout and support. As well, TLP teachers frequently served on building or district technology planning teams, helping to develop, implement, or evaluate technology plans and policy.

A number of TLP teachers also shared their expertise by making presentations at professional conferences, including the Washington State OSPI Assessment conference, the WSASCD conference, and the NCCE conference. A few participants also found opportunities to teach or participate in college classes, most often demonstrating to pre-service teachers how to integrate technology into the curriculum.

When the leadership activities of first and second year TLP participants were compared, the most obvious difference was not in the ways they took on leadership roles, but rather the timeline they followed for doing so. Second year teachers, as might be expected, were more likely to be involved in structured sharing opportunities earlier in the year. The one other difference seemed to be that second-year teachers were more often involved in writing school or district grants for funding technology projects.

While teachers' leadership efforts benefited many others, journal responses suggested teachers benefited, as well. They shared examples of how they had grown personally and professionally over the course of the year, in large part because of their work with technology. For some, this came from offering technical assistance or teaching a class in the building, while for others it was doing a presentation at a state conference. Whatever the specific event, these teachers gained a sense of confidence and credibility that they had not known before as classroom teachers. The training and experience that come from involvement in the TLP seemed to open up opportunities for both personal and professional growth that teachers might not otherwise have had.

Students, like their teachers, spent a considerable amount of time sharing their expertise with others. In many cases, students offered technical assistance to other students, other teachers, and even administrators. They presented projects to School Boards, Parent-Teacher groups, and to their families and community members during Open House evenings, Curriculum Nights, and Technology Fairs. Reflections from teachers provide insight into leadership experiences:

> *"Our staff has four Gates TLP recipients and we were part of an in-service for our school last week. The day was dedicated to technology and I taught a PowerPoint class and others taught a Word class. The staff chose which class to attend and alternated it with our tech specialist teaching about our new email network. This was a good method because people were able to choose what they needed and also work in a small group so they could ask specific questions about what they were interested in. This was helpful because as in all buildings, we have a wide range of experience with technology. We also offered to anyone who would like to create a PowerPoint presentation for Curriculum Night next year, the use of our laptop and presentation device. A few were excited about this and began creating their presentation at my class."*

> *"We had a second round of training our staff on topics of their choice. I taught excel again and had good results. Students in my room have been trained with the digital cameras and can be seen around the building snapping pictures of activities. These can be found decorating the hallways."*

> "*As an update to last month's entry, my T. L. P. partner and I have successfully presented a program to staff and P. T. A. for the phase in of new computers into the classroom rather than the purchase of a remote*

lab. The plan has been approved and the first phase of hardware has been ordered. Teachers are very excited. The process included a presentation to the P. T. A. and the building Site Council. Both presentations went very well and led to enthusiastic support for the plan. The P. T. A. will be a major donor to the program over the next three years. Also, we held our first "help desk" on PowerPoint and had eight teachers attend one day after school. Several of them are already using it with their kids. The building principal has agreed to give us every other staff meeting to use as technology training time with the staff. This will begin in January with a session on "the basics" such as file management, network resources, and e-mail."

"We have begun a series of technology classes open to the public as well as our staffs. We had an over full house this last one. Many of my parents took us up on an offer to learn basics using Windows. Many of my students attended evening workshops with their parents."

"We have another Lid Day coming up. It is to be another Tech Day. My partner and I have been asked to teach an intro to Word, PowerPoint, and Excel again. I would like to share what I learned at my last Teacher Leadership Project meeting. The mini class was "Forms with Word". This was a big hit with those attending. I know our teachers here at TMS would find it as exciting as we all did. I just need to get it on the agenda and leave it up to the teachers. On our last Tech Day, Word was very popular even though most of the participants did not have Word on their computers."

"The dialogue this program has created has been a very positive one for our teachers, students and school."

"This program has seemed to dictate our role as technology integration leaders in our building. Colleagues are frequently in our classroom asking questions, getting ideas, asking for troubleshooting support and just seeing what we're doing. I am also frequently e-mailing our entire staff lesson ideas, web sites, sample projects and digital photos of our class work. Our student work is shared on the computers in the lab as learning tools for other classrooms. Our students also have become technology buddies for other classes. They partner up with students from other classes while I teach a lesson in the lab that my students have already done. That way my students can serve as the coach for the less experienced technology student. The dialogue this program has created has been a very positive one for our teachers, students and school."

"The BEST part was after school... I was teaching the Paraprofessionals a lesson on Word features... I brought in 8 students for "helping hands" and taught the lesson. It was unbelievable... (the) students were awesome, (and) we covered about 3 times more material than was planned,

> *as they had one on one help. They begged me to bring them back this month when we do Power Point! I have never seen a group of kids take such a leadership role... I was only there to help with "serious problems!!"*

Summary

Clearly, TLP teachers and their students responded to the call to share their training beyond the confines of their individual classrooms. Whether they taught classes, offered technical assistance, made presentations, or served on technology committees, teachers shared their knowledge, skills, and resources to raise awareness and develop skills in the area of technology integration. Their efforts have not only raised awareness of the potential for infusing technology into the curriculum, but have also provided non-TLP teachers with skills and curriculum ideas for pursuing technology-enhanced instruction.

Evaluation Question 6: *What is the appropriate use of the technology for K-2 students?*

During the 2000-2001 school year, primary teachers (grades K-2) were included in the Teacher Leadership Project for the first time since it's inception. While there was a general consensus about the need for placing technology in primary classrooms, there were also questions about the appropriate use of computers with young children. Educators and other professionals who work with and for young children have become more vocal over the years about the importance of developmentally appropriate practices for primary-age children, stressing the need for hands-on, concrete, interactive experiences. Are "traditional" activities, such as pencil and paper composition, coloring and painting and exploring with math manipulatives, neglected in primary classrooms when technology is added? Are there physical, social, or emotional risks involved when young children use computers on a regular basis?

These are questions that prompted an in-depth study of K-2 TLP classrooms. "Both critics and proponents agree on the importance of the early years in a child's physical, social, emotional, and cognitive development. Much of the controversy revolves around the specific needs of young children, and whether technology can support those needs, or will take away from essential developmental experiences" (Van Scoter, Ellis, & Railsback, 2001, p.1). According to Jane Healy, author of several books on learning and young children, "An atmosphere of hysteria surrounds the rush to connect even preschoolers to electronic

> **"While some very exciting and potentially valuable things are happening between children and computers, we are currently spending far too much money with too little thought. It is past time to pause, reflect, and ask some probing questions"**

brains" (1998, p.20). She is one of a growing number of professionals raising concerns about the impact of placing sophisticated technology in the hands of preschool and primary age children. "While some very exciting and potentially valuable things are happening between children and computers, we are currently spending far too much money with too little thought. It is past time to pause, reflect, and ask some probing questions" (Healy, 1998, p. 18). Those who challenge the assumption that technology must necessarily be a part of the primary classroom cite numerous potential problems that may result from computer use, including risks to:

- Vision (strain to the eyes, blurring, itching, double vision)
- Musculoskeletal systems (back, shoulder, neck, arm and wrist strain)
- Physical health (obesity due to lack of outdoor activity)
- Emotional, social, and personal health (working in isolation, addiction, lack of time for reflective thought, overstimulation, passive learning)
- Moral health (potential exposure to inappropriate advertising, internet sites, ease of plagiarism)

Specifically, it has been suggested that "Computers pose serious health hazards to children. The risks include repetitive stress injuries, eyestrain, obesity, social isolation, and, for some, long-term physical, emotional, or intellectual developmental damage…Children need stronger personal bonds with caring adults, yet powerful technologies are distracting children and adults from each other….. Children also need time for active, physical play; hands-on lessons of all kinds, especially in the arts; and direct experience of the natural world. Research show these are not frills but are essential for healthy child development" (Cordes & Miller, 2000, p.3).

Given the concern among researchers and educators about the appropriate place of technology in primary grades, one component of the evaluation was an in-depth study of participating K-2 teachers and classrooms. Data were gathered from monthly reflective journals, the online TAGLIT survey (K-2 teachers only), interviews of twenty-one K-2 teachers, and observations in those classrooms. The following report will summarize (1) ways in which the technology is used in primary classrooms; (2) successes and benefits of integration at the primary level; (3) challenges to using technology with young children; and (4) recommendations.

Computer Use in Primary Classrooms

Like their intermediate and secondary counterparts, K-2 teachers utilized their technology for a variety of activities, using a number of different programs.
Most frequently used programs and applications included:

- Word/Kid Pix
- Draw/Paint
- Power Point
- Internet/Encarta
- Skill development programs

- Accelerated Reader
- Excel

And related technologies:

- Color Printer
- Digital camera
- Scanner
- Presentation device

Although their use differed somewhat depending on the specific grade level, word processing (of stories, poems, descriptions, and the like) was a frequent activity in primary classrooms. Teachers used both Word and Kid Pix for these tasks, although by the end of the year most teachers found that their students were able to use Word adequately. Excel was used for graphing, more often by second grade teachers. Primary students also used Power Point for presentations, including "All About Me" reports, animal and country reports and holiday presentations. In kindergarten and first grade, students were more likely to make one slide, while second graders often designed presentations with several slides. Kindergarten and first grade teachers also used Power Point and Excel, often as a teacher tool or in a combined class activity, rather than as an individual student activity. Primary teachers used the Internet with their classes as well, giving students the opportunity to read and view information on topics being studied.

While a few teachers reported that students could conduct their own basic searches, most found it more successful to pre-identify and bookmark sites for students to access during class time. Encarta was used occasionally, although teachers who had other, more "primary appropriate" electronic reference sources preferred those because of the reading level. Draw software was also used regularly. After receiving instruction on developing and using templates at a regional training session, primary teachers used them on a regular basis. Hyperlinking, also the subject of a training session, was used less often, particularly by kindergarten teachers. Skill development programs such as Reader Rabbit and Math Blasters were popular with primary teachers, as was Accelerated Reader. While intermediate and middle school teachers found SchoolKit extremely helpful in developing sequential learning skills and conceptual understanding, most primary teachers found it too complex for their students. It did seem that technology was integrated *least* often into the math curriculum. This excludes the use of skill development software, however, which was used regularly. A description of "typical" activities follows:

Writing. Kindergarten - Students use Word or Kid Pix to practice writing their names, to write stories, or create word lists. Skill software is used to reinforce the alphabet, letter sounds, etc.
1st Grade – Word or Kid Pix is used to word process final drafts of stories and reports, and to practice spelling words. Publisher is used to create invitations and brochures.
2nd Grade – Word or Kid Pix to type final drafts of stories, poems, reports, letters, to label diagrams, and to practice spelling words and sentences. As with first graders, Publisher is used to make invitations, calendars, and the like.

Reading. K,1, and 2nd Grades – Accelerated Reader to take comprehension tests, the Internet and Encarta to read information for reports. Computers are also used with programs that allow children to "read along."

Science. K,1st and 2nd – Internet, Encarta, and other electronic references to gather material for reports on water, animals, weather, etc.

Math. Skill development programs are used for number, shape, and pattern recognition, sequencing, and in some cases basic algorithms. Some work with basic graphing, mostly teacher led. K, 1st and 2nd Grade – Graphing with Excel, practicing basic math facts, number recognition, pattern and shape recognition.

Art. K,1st and 2nd – Kid Pix, Draw, and Word Art to illustrate stories and poems.

Results of the TAGLIT survey on technology use (Table 2) indicate teachers' perceptions of the ways they use computers and related technologies in the classroom.

Table 2

K-2 Teachers Use of Technology for Teaching and Learning

"How far along are you in enhancing teaching and learning using..."

Application	3 Conscious Effort	4 Natural and Powerful Use	Total 3 and 4
Word Processing	52.9	36.3	89.2
Draw/Paint	45.1	26.5	71.6
Presentation Software	47.1	23.5	70.6
Digital Camera / Scanner	36.3	29.4	65.7
WWW-Research	32.4	31.4	63.8
Online References	32.4	25.5	57.9
Subject-Specific Software	37.3	16.7	54
Multimedia	31.4	15.7	47.1
E-mail	22.5	23.5	46
Spreadsheet	23.5	6.9	30.4
WWW-Publishing	17.6	4.9	22.5
Video	15.7	2.0	17.7
Database	10.8	1.0	11.8

(N= 102)

Excerpts from teacher journals provide a useful summary of what was done in primary classrooms:

> *"The next project that we are working on is to make a Mother's Day card on the computer and then print them. The children will be shown how to design the card using clip art and their own words. I will use the writing process to complete this project. I will have the students use the peer editing process for the cards before printing. My parapro or I will need to do the final edit."* (K)

> *"Kid Pix is still by far the best program to use for the primary. Slide shows and publishing is the best. This last week we studied Mexico and we created a book on Mexico. The students used illustrations in kid pix. They had to draw 'postcards from Mexico'"* (1st grade)

> *"Students continue to use technology for publishing. Students are having more success in their individual efforts using the computer for publishing. Most students are now proficient opening a Word document and saving the file properly. They are doing a nice job on keyboarding. This success frees my time so that I can help those struggling with the writing process... This month we learned the process of using Kid Pix to put together a slide show. This is in preparation of our next unit in which I am including a slide show as a project and assessment piece. I'm hoping to give my more advanced students the opportunity to learn Power Point also. Students put together a 3 to 5 slide show that included a title page, transitions and sound effects."* (1st and 2nd grades)

Benefits of Technology Use with Young Children

Teachers cited countless successes in integrating technology into the K-2 curriculum. These can be loosely categorized as (1) technical benefits; (2) academic benefits; and (3) attitudinal benefits, and although there was some overlap, there were also differences between grade levels.

Technical benefits included the development of skills that allowed children to manipulate and navigate the various computer tools and programs. Teachers, as well as parents and administrators, were surprised at how skillful primary age children were at getting into and out of programs, changing fonts, saving documents, and using a mouse. While some teachers felt that Word was too complex for their students, most discovered that it could be used reasonably well by the end of the year. At the very least, teachers felt that their students had been given a good foundation in using basic computer technology, and were being well-prepared for future educational experiences in which technology was included.

Academic benefits were more difficult to isolate, simply because objective measures and longitudinal data were lacking. The most noteworthy finding was in the area of writing. Teachers observed that students were more inclined to write, to edit, and to revise their work when they were able to use computers. This was true primarily for 2nd graders, as they tended to do more writing than kindergarten and 1st grade students. In addition, 2nd grade students were more capable at keyboarding, which made the writing process less laborious. While younger children were slow at both handwriting *and* keyboarding, they were nevertheless more highly motivated to use the computer. In addition to seeing benefits in writing, teachers also expressed satisfaction with the degree to which children used, and learned from the Internet, Encarta, and other research tools. Again, this finding was stronger at 2nd grade, although all primary teachers electronic references at some level. Those teachers who used Accelerated Reader with their students were convinced of the positive impact on reading skills and comprehension. They also felt that time spent using the Internet, Living Books, and other programs that required extensive reading were advantageous to students. For younger students, computer use helped with letter, number, and word recognition. In math, teachers found that the graphing possibilities in Excel helped students share and understand the data gathering and analysis process. It was also the opinion of teachers that sequencing and patterning, as well as the ability to follow multi-step directions were all developed more fully because of computer access. Finally, teachers consistently discussed the improvement in both the quality and quantity of work completed by students. Computer technology allowed them to produce polished, professional looking documents and presentations, of which they could be (and were) proud.

The most significant benefits, however, were found in the area of *student attitude*. As with older students, primary teachers noted time and again that students were motivated to be in school, to learn, to ask and answer questions, and to complete schoolwork because of their access to computers. To be sure, the motivational influence of computers cannot be overstated. Mentioned only slightly less was the degree to which technology encouraged collaboration on the part of young children. It was also suggested that computers encouraged children to collaborate and help those with whom they might not normally choose to work. Gender, ethnic, and ability barriers seemed to dissolve when children were working with technology. Teachers found as well that self-concept, level of independence, responsibility, and on-task behavior were all improved due to technology experiences. Lastly, teachers stated that students developed leadership skills because of the addition of computers to the classroom. In some cases, younger students were able to share their knowledge and skills with older students, and frequently they shared their expertise at home with parents and siblings. This was powerful for them, and impressive for their audiences.

All in all, teachers were consistently and enthusiastically positive about the many ways in which technology benefited their students. Besides becoming technically savvy, teachers believed students' academic skills and attitudes were enhanced because of their ability to use computers for learning.

Teachers' perceptions of the influence of technology on the classroom practices, according to TAGLIT results, are shown in Table 3. All in all, teachers were consistently and enthusiastically positive about the many ways in which technology benefited their students. Besides becoming technically savvy, teachers believed students' academic skills and attitudes were enhanced because of their ability to use computers for learning. Classroom observations generally supported teachers' perceptions. Student motivation to use computers for learning projects was unmistakable, and they appeared to be quite competent in what they were able to accomplish with the technology. Students were generally confident when using the computers, and took great pride in the work they accomplished. Students were consistently, across grades and schools, enthusiastic about helping and sharing with each other. Power Point presentations, brochures, and illustrations were polished and professional looking when done with the computer. The positive impact of Accelerated Reader was also impressive, as were the graphs they were able to construct. Less dramatic were primary students' word processing efforts. Access to computers seems to significantly enhance creative writing efforts in older students who have learned the basics of spelling, grammar, and punctuation and can therefore concentrate on their ideas and language. This does not seem to be the case for primary students. While there was indeed high *motivation* to use the computers for writing, the outcome of such activities seemed to be mitigated by a lack of keyboarding skills. However, perhaps the motivation to type and the degree to which this facilitates letter recognition is enough to justify a young child's use of computers for word processing.

Table 3

K-2 Teachers Use of Technology and the Classroom Environment

"As a result of your use of technology in teaching and learning, are you more inclined to involve students in…"

Classroom Practice	3 Quite a Bit	4 Very Much	Total
Engaging activities	33.3	58.8	92.1
Cooperative learning	32.4	50.0	82.4
Higher order thinking skills	41.2	35.3	76.5
Interdisciplinary activities	40.2	33.3	73.5
Alternative assessments	41.2	29.4	70.6
Individual assistance	40.2	16.7	56.9

(N= 102)

The following reflections from journals illustrate teachers' perceptions about the benefits of computers in teaching and learning.

> *"The computer center is a favorite. The children have learned computer skills and computer vocabulary during the year. They also have learned*

> *academic concepts and skills in a fun way and do not hesitate to repeat the activities until they have the confidence that they know it…"* (K)
>
> *"I have seen what can happen when you incorporate technology into what we are teaching even at the K-1-2 level. I believe my children's reading and math skills are stronger and their ability to work together as a team is much stronger also.*
> *While this age child may not be doing the kind of research that is commonly seen at the upper grades, there are many valid, useful skills they are learning at this age. If they had the fine motor skills to use the keyboard, I have no doubt they would be able to do the higher-level research skills that are seen at the upper grades. The motivation to use the computer would and does encourage them to use their reading skills in a natural environment because they are interested in learning. The ability to figure out a way to show their answer using the computer in math is exactly the kind of higher thinking skills we are asking the children to do on the WASL."* (K,1,2)
> *"They seem to be increasingly comfortable using the keyboard and recognizing commonly used word in manipulating various programs. Whether they have learned to recognize letters and words differently or more easily because of technology is hard to say, but I am able to identify what they know more readily as I observe their work on the computer."* (K)
>
> *"I feel the world around us is at an arms length with the help of the technology in our classroom. We are able to view current events, write letters, create final projects, give presentations, share with other students, use software and new hardware, etc… I love the motivation I see in my students, their desire to help others and share information. They are developing their skills as independent learners."* (1st grade)
>
> *"Their "different" learning is their thinking skills that they are displaying while working with their peers, researching on the internet toward a common goal. The evidence is in their ability to cooperate, problem solve, think critically, and reach a goal in the positive way. These skills are much more advanced than they have ever been with any group of students that I've taught."* (2nd grade)

While most teachers were convinced that technology was valuable to the educational experience of young children, some were not yet persuaded.

> *"As always, it is still difficult to state there has been significant, measurable learning growth caused by having computers in the classroom. Yes, they will be more familiar with a keyboard, mouse, and desktop functions. They'll become familiar with age-level appropriate programs that will transfer to real world applications. Is there learning*

> *taking place that couldn't be done just as well in a traditional classroom, especially for kids at this concrete, hands-on stage? Maybe I'll find out next year when we loop up together to first grade."* (K)

> *"I do not see how their general learning has been enhanced by technology in the classroom. They do enjoy the computers and are excited about everything we do. They have learned a lot about using computers, which is important in this day and age. They are becoming more confident about their technology knowledge which is fun to see. It's great to see them help each other when there's a problem. They can do much more than they could in the fall. So I guess they have learned something..."* (1)

Challenges and Concerns about Technology Use with Young Children

In many cases, primary teachers' observations about the challenges of technology integration were the same as those expressed by intermediate and secondary teachers: technical glitches, lack of technical support, and lack of time to plan meaningful lessons. However, some challenges were unique to the primary grades, and will be discussed here. These include (1) the lack of developmentally appropriate software; (2) reading level of 5-8 year olds; (3) student management; (4) fine motor coordination related to keyboarding, and mouse control; and (5) TLP training.

The main challenge to using the technology effectively, according to primary teachers, was the lack of developmentally appropriate software.

Software. The main challenge to using the technology effectively, according to primary teachers, was the lack of developmentally appropriate software. Each grant recipient was provided with the basic Office applications in addition to the computers and related equipment. Most found, especially at the beginning of the year, that these were too sophisticated for 5-8 year old children, and they were thus frustrated in their efforts to integrate technology. Many teachers supplemented the basic software package with skill development programs (Reader Rabbit, Math Blasters, Jump Start, etc), less complex word processing programs (Kid Pix), math programs (Graph Club), reading and writing software (Living Books, Accelerated Reader, Kidspiration) and reference programs. These made a huge difference in how teachers were able to use the computers. However, by the end of the year, a majority of 1st and 2nd graders had become fairly skilled with Word, Excel, and Power Point. Kindergarteners used these applications as well, although somewhat less efficiently than their older peers.

Reading Ability. Most primary teachers felt that a student's reading level was a limiting factor in how extensively the Internet and Encarta could be used independently. Even when teachers identified sites ahead of time, much of the information was beyond the reading level of primary students. These perceptions were supported by classroom observations. Students had varying degrees of success in gathering information from websites and Encarta, even when they did not have search for it. When the material was at an appropriate reading level, they were able to use it effectively. However, when they were expected to gather information from Encarta, or other sources with a relatively sophisticated reading level, it appeared that they limited their efforts to looking at the pictures and reading some of the headings. Many actually ended up getting the information they needed from primary level library books.

Management. Teachers of kindergarten and first grade, and to a somewhat lesser degree second grade, struggled with student management as well. Children at this age, while amazingly competent on the computers, are not completely independent. It was not uncommon for teachers to comment on how much easier the process would be if they had another set of hands. In those cases where they had access to intermediate students, parent volunteers, or paid aides, they were, in most cases, able to accomplish more, both faster and more easily. Several questioned how computers could be used effectively in primary classrooms *without* additional help.

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Generally, two children seemed to be able to work together cooperatively and effectively on a given task. When three or four were expected to complete a project together, it was the case more often than not that two would be working and two would be doing something else unrelated to the given task. Some teachers attempted to overcome this challenge by having groups of students work independently on a computer project while they taught another group. However, this proved difficult as well. Even when the task was clearly explained at the outset, once students were on their own, they inevitably had questions or technical glitches that they were unable to handle. If teachers left their instruction group to help at the computers, then *those* students would generally become off-task and lose focus.

The inability of a teacher to directly monitor and facilitate computer projects was problematic. Off-task behavior was more common than teacher's journals would suggest, and it was not unusual to see students spend their entire block of computer time typing words, sentences, or a paragraph, only to delete the work, type it again, change fonts, delete it, and type it again, until their time was used up. Likewise, it was unclear how much learning was actually taking place when students used skill development software in isolation. Watching them move quickly from one activity to another gave the appearance that they were more interested in the graphics and sounds than in any skills that were being presented. On the other hand, when teachers were available to guide students in their use of practice software, it appeared that more learning took place.

Clearly, a student's time on the computers was more productive and effective when the teacher was aware and involved in what they were doing. This was true across grade levels.

Motor Skills. To a lesser extent, primary teachers found that a student's lack of fine motor skills made keyboarding difficult and slow. While true for older students as well, it was certainly more limiting to younger students. Word processing short stories, paragraphs, and even sentences tended to take a long time, and there was a lack of agreement on the part of primary teachers about whether or not keyboarding instruction made a difference. Observations suggested that even when students *had* been given keyboarding instruction, it did not necessarily transfer to the work they did on the computers.

Training. Another challenge faced by K-2 teachers was related to the initial training they received at the outset of the program (summer session). Most felt that the shared lessons, projects, and management strategies, while valuable and appropriate for intermediate and secondary students, required significant modifications before they could be used effectively in primary classrooms. As many noted in journals and interviews, it is no small task to adapt a 5th grade lesson for use with 1st graders. Although similar concerns were expressed about the first regional meeting, changes were made for the final two sessions in which the needs of primary teachers were addressed.

Selections from teacher journals illustrate their perceptions about the challenges to technology integration.

> *"This month we are still working on our Power Point presentations. I had originally planned for this to take two weeks and we're on our fifth week. The amount of time it is taking is rather exasperating."*

> *"I continue to battle time restraints. It takes so much time for some children to complete a task on the computer even with buddy help."*

> *"The Kid Pix software is much easier for the students to use. It would be good to have more user-friendly software for first graders than what we were given. I also wish that summer training had consisted of more computer training for me. Having never done Power-point before and then having only an hour help desk to have to create a show was rather stressful. I also have ideas but I do not have the ability on the computer to know how to create them."*

> *"...I'm also frustrated that there are very few resources available that my students can read and comprehend without my help."*

> *"The biggest challenge is to design lessons that allow the students to actually create a finished product independently."*

"...I am also still dealing with getting the kids to be independent on the computers so that when they are working on something on the computer and something unexpected goes wrong they can either problem solve it for themselves or ask another child in the class to help them so that I am not being taken away from the group of children that I am trying to work with at that time."

"Not being able to read limits your ability to get rid of the little gray boxes that pop up out of nowhere."

"... They have a lot of difficulty waiting for their turn. I can see that it would be nice to get network extension cables and cross floor protection for power cords, etc. so that we could work as teams at our tables instead of being lined up against the wall in a long row. This would allow us to cooperate on a project. But first they need to know the basics of getting around the desktop, keyboard functions, mousework, and machine problem-solving. Not being able to read limits your ability to get rid of the little gray boxes that pop up out of nowhere."

"I would say that the biggest challenge for myself, at the present, is discovering ways to use the computers with the kinders to enhance their learning."

Placement. One of the concerns about placing technology in primary classrooms has been the possibility of strain on the eyes, shoulders, back, neck, and wrists. Most K-2 TLP classrooms seemed to be set up such that students could easily see and access the computers. However, in some situations arrangements were less than adequate for young children: level of the chair, distance from the screen, number of children trying to see the screen, etc. Whether due to lack of appropriate furniture, lack of space, or other restrictions, this is an issue that should be considered.

Developmentally Appropriate Activities. Of those teachers that addressed this issue, nearly every one said that adding technology to the classroom *did not* limit what they did in the way of traditional, hands-on, developmentally appropriate activities. Teachers by and large said that they were committed to providing a solid education to these children, and if that meant that they did not use the computers for a couple days in a row because they were involved with "traditional" lessons, then that was fine. Observations seemed to bear this out. As an example, nearly all primary teachers required students to hand-write rough drafts of stories, poems, and the like, and then do final drafts on the computers so that they would continue to develop their handwriting and other fine motor skills. In short, there seemed to be a strong commitment on the part of these teachers to

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Equipment. All TLP grant recipients are provided with enough computes to achieve a 4:1 ratio in their classrooms. Whether or not it is essential that primary teachers have the same student to computer ratio as teachers of intermediate and secondary teachers is not clear at this point. Given their limitations in functioning independently and the challenges faced by teachers in monitoring them, a reasonable argument could be made that funding would be better utilized by providing fewer computers and more auxiliary hardware. This seems to be particularly true for K-1 classrooms. A sensible and practical configuration might include several computers, a presentation device, digital camera, scanner, high quality color printer, and several Alpha smarts. The projection device seems to be a critical piece of equipment in primary classrooms. Trying to teach a lesson or share student presentations on a television screen was frustrating and only minimally effective. Given the difficulty faced by primary teachers in having their students work independently, it may indeed be advisable to consider shifting priorities in terms of the hardware provided to K-2 teachers.

The following comments from a teacher of grades K-5 illustrates the challenges inherent in using technology with young children:

> *"Most of the challenges revolve around my youngest students. I have to admit that I don't feel the same urgency to give them quality computer time, although they do spend time on the computer every day. I feel that my first duty to them is to get them reading and writing well and to give them a good math foundation. I search for things that help to reinforce those basics. I guess I prefer more hands-on tactical learning for these young students. In my situation, I know I will have these students for several years to come and plan to build on their computer skills from year to year. I know they will have time to explore the computer more in the years to come. I do give more direct computer teaching to my older students. Whether that is the right attitude to take I guess time will tell."* (K-5)

> ***"I feel that my first duty to them is to get them reading and writing well and to give them a good math foundation. I search for things that help to reinforce those basics."***

Recommendations

Teachers of grades K-2 used their technology extensively during the 2000-2001 school year to support student learning. Students not only learned to manipulate computers, printers, and various software programs, but also reportedly showed improvement in their academic skills, attitude and behavior. The quality of their work was impressive, and the degree to which they collaborated with each other was impressive to teachers. On the other hand, there were also several challenges faced by teachers as they worked to integrate technology into the primary curriculum. Given the lack of specialized training for K-2 teachers, the experiences of this first group of primary teachers is probably not adequate to draw final conclusions about the potential of the TLP for young children. The following are ways in which the K-2 component of the Teacher Leadership Project could be strengthened.

1. Provide relevant and specific instruction for K-2 teachers, both at the initial summer training and follow-up training sessions.

2. Provide developmentally appropriate software for K-2 teachers, including Word and Kid Pix, Excel and Graph Club, and primary reference software.

3. Consider modifying the hardware provided to K-2 teachers:
   - Require a presentation device, color printer, digital camera and scanner
   - Fund fewer computers but include Alpha smarts for flexibility in word processing

4. Establish a separate K-2 listserve for questions, sharing, and discussion purposes.

5. Continue the evaluation of the K-2 program for analysis of longitudinal data.

6. Distribute a "handbook" to all K-2 participants, including:
   - Developmentally appropriate websites
   - Scope and sequence /scaffolding plan for introducing technology
   - List of developmentally appropriate, useful software
   - Recommendations on keyboarding instruction and/or programs
   - Room arrangements and considerations
   - Student management strategies
   - List of reference materials related to primary integration

Summary

Teachers identified a wide range of benefits in utilizing technology with primary age children. These include technical benefits (knowledge of programs and applications), academic benefits (reading, math concepts, writing, final products), and attitudinal benefits (motivation, self-confidence, collaboration). Teachers experienced challenges as well, such as a lack of developmentally appropriate software, student management issues, limited reading ability of primary students, undeveloped fine motor skills, and inadequate initial training in integrating at the K-2 level. To their credit, the Teacher Leadership Project addressed the training issue during the school year, and modified regional training sessions to more directly meet the needs of K-2 teachers.

Finally, while patterns of use, benefits, and challenges have become much more clear over the past four years regarding technology integration in intermediate and middle school classrooms, patterns at the K-2 level have just begun to emerge. It appears, for example, that young children can learn to navigate within and between programs, do basic word processing, design simple Power Point presentations, complete directed

Internet searches, and practice basic skills. Questions remain about the necessary and appropriate hardware and software for primary classrooms, types of training that best support primary teachers in their integration efforts, and management strategies that work best with a classroom of 5-8 year olds. In light of these remaining questions, it seems prudent to continue the evaluation of the primary component of the Teacher Leadership Project. The need for longitudinal data was emphasized by Clements, Nastasi, and Swaminathan in their discussion of technology integration and young children. "Realizing these benefits also requires sufficient computer access and time. One group of researchers stated that if they had stopped their evaluation after only a couple of months, they would have mistakenly concluded that there were no effects. Only after one full year did the rich benefits emerge" (1993, p.59).

Questions remain about the necessary and appropriate hardware and software for primary classrooms, types of training that best support primary teachers in their integration efforts, and management strategies that work best with a classroom of 5-8 year olds.

Additional Research and Evaluation Findings

While the evaluation of the TLP focused on six primary research questions, findings not directly related to those questions are worth noting. These include: (1) teacher reports of particularly successful projects, strategies, and positive outcomes of technology integration, as well as (2) challenges to the integration process. And while the evaluation was not focused on students' perceptions, TAGLIT data nevertheless gives some insight into their attitudes about technology and their computer skills.

Successes in Integrating Technology into the Curriculum

Despite the considerable time and effort that goes into technology integration, there were many positive outcomes, according to TLP teachers. Across grade levels, they saw greater motivation, on-task behavior and collaboration, improved problem-solving abilities, and a willingness to edit and revise written work. There was also a sense among teachers, although generally not quantifiable, that students are learning more due to the infusion of technology. Quality of student work was much better and communication skills were more highly developed when they were able to use technology. Finally, most of the feedback received from administrators, parents, and community members was enthusiastic and positive. Teachers also discussed the impact of technology integration on their teaching, and many observed that it had caused them to be more child-centered and intentional in their instruction.

Motivation, Collaboration, On-Task Behavior, Independence, Responsibility. Specific examples of successes were many. Again and again, teachers cited instances of the motivating influences of technology. More than simply excitement about having lots of computers, students were excited about learning because of having access to computers. It was not uncommon for teachers to share anecdotes about students doing independent research, going beyond the requirements of an assignment, working on assignments at home, during recess, or before and after school. Kids have always asked "why?" of course, but did not necessarily have the desire or motivation to pursue an answer, even when resources were available. Access to the Internet and other electronic resources have dramatically changed this scenario. When students, regardless of age, had a question, they wanted to find the answer. The fact that electronic resources offered immediate information, as well as a degree of active participation, appealed to kids. If there is a relationship between motivation, meta-cognition, and learning, as Sternberg suggested (1998), then the motivation factor inherent in computer use may indeed be essential to transforming teaching and learning.

From kindergarten to high school, students were more inclined to work together cooperatively when technology was involved. Moreover, students were more likely to work with students they might normally have avoided.

Teachers were also surprised at first, and convinced, over time, of the value of computers in facilitating collaborative behavior in students. From kindergarten to high school, students were more inclined to work together cooperatively when technology was involved. Moreover, students were more likely to work with students they might normally have avoided.

Students exhibited other positive behavior changes in the classroom, according to teachers. Integrating technology into the curriculum has caused them to focus more attention on their schoolwork, and to stay focused for longer periods of time. This seems to be due, at least in part, to the fact that they were actively engaged in what they were doing, but also due to the "real world" nature of the tasks that were accomplished on the computers. Students took more responsibility for their own learning, and became more self-directed in their approach to assignments. All in all, a majority of teachers reported a number of positive attitudinal and behavioral changes in their students due to the infusion of technology. Most students had been in classrooms where one or two computers were used for playing games and practicing skills; many expected the Gates computers to be more of the same. Although initially disappointed when this proved not to be true, students became, over the course of year, even more excited about the academic potential of computers. In any case, the integration of technology did lead to a transformation of students' attitudes and learning behaviors, as teachers' comments reveal:

> *"They are possessed! They are sharing! They are excited! They are learning!"*

> *"In many cases, I feel the student perception of the computer has shifted from it being fun and games to it being a useful tool. I feel students are more helpful and their directions to each other clearer because of helping each other in troubleshooting or task-related situations. This has created what I call a "positive intolerance" of off-task students by other students. Because they work in groups, efficient use of time is reinforced. This is a life-skill."*

> *"Evidence I have that suggests students are learning differently and/or more because of the addition of technology to the curriculum is their motivation and the pride they take in their work. I really notice a difference in the amount of time and effort students are willing to put in when technology is involved. I have students asking to stay in at recess or come in before or after school to work on projects. It is wonderful to see their enthusiasm for learning!"*

Communication.

While teachers reported numerous benefits (attitudes and behaviors), they also discovered that technology integration had a positive impact on academic outcomes. Most often this was related to writing and speaking. Teachers shared numerous examples of the ways in which student writing was improved due to technology access. The traditionally boring tasks of editing and revising become much less objectionable when students had the ability to quickly and easily make changes on the computer. As a results their written pieces were longer, more creative, and of better quality in the end. This finding became more apparent in the upper grades. They were willing to devote more time to composition when they knew they would not have to "erase and re-write, erase and re-write….".

"One reason I know that technology has increased learning is that it has increased the motivation to learn, especially when using technology as a tool. Students seem to blossom at the computer and their ability to work with each other also blossoms. It's interesting how cooperative work groups happen so naturally at a computer."

Oral communication skills improved as well because of student's use of Power Point for presentations. While kids have always presented reports and papers with their peers, the slide format, the hands-on development process, and the potential for producing a high quality product together seemed to motivate students to go beyond the traditional note-card and poster presentation. Beyond that, when students stood in front of a group and talked from an on-screen outline, they were more aware not only of what they were saying, but also of the details of their slides. They understood the importance of font size and color, sounds, key facts and layout, and the effect these have on an audience. Examples from teachers follow:

> *"The kids are much more motivated to write knowing that their final products will be a "things of beauty." Revision and editing is much less of a struggle—they are willing to put forth the effort knowing that they'll get the chance to word process once they have polished their piece."*

> *"I know I've said this before, but I'm extremely pleased with how much easier it is to teach writing using technology. My lessons are clearer and better paced using the laptop and projector to teach."*

Quality Products

Another positive outcome of technology integration was the degree to which students were able to produce high quality work. The professional look that could be achieved through word processing, computer-accessed graphics and online research allowed students to create reports, projects, and presentations of which they could be very proud. Parents, community members, and administrators were often surprised at the outstanding results achieved by students when they used technology. Teachers also shared examples of how technology levels the playing field. Students who did not normally produce high quality work, for whatever reason, were able to create lessons equally as presentable as those of their higher ability peers.

One of the rewards of technology integration was the way in which some lower ability students found their technical "niche." Students who often had no particular talents, or at least none recognized by peers, often discovered that they had technical abilities that their higher-achieving classmates did not, and thus received a certain respect that they ordinarily would not have.

Along the same line, one of the rewards of technology integration was the way in which some lower ability students found their technical "niche." Students who often had no particular talents, or at least none recognized by peers, often discovered that they had technical abilities that their higher-achieving classmates did not, and thus received a certain respect that they ordinarily would not have. Their own confidence was bolstered, and in some cases these kids began to see school and learning in a new light. Excerpts from teacher journals provide evidence of the high quality work students were able to produce:

> *"The products are so much better and students take great pride in their work. Parents have commented to me that their children talk about things they are doing on computers."*

> *"IEP/special needs students 'blend' in with 'regular' students when provided these fantastic tools. Student work more closely resembles real life examples: newspapers, newsletters, forms, posters, etc."*

> *"I want to say that the one thing that has stood out most to me during this year is that each student has been able to have the opportunity to play on the same playing field, using the same rules and the outcome has been astounding! Their work looks neat and professional. They still have many opportunities to be creative, but they have a new vehicle to use and incorporate in their toolbox. We've only just begun!!!"*
>
> *"My IEP students continue to amaze me. It is so rewarding to see quality projects presented by students who otherwise would never even think of volunteering to share. I have three non-readers, and they take special pride in the work they have done (with assistance). In the past, these students would avoid working on a project. Now they NAG continually for the opportunity to work on their projects.*
> *Before this year, PowerPoint was taught as a special program for our highly capable students. Now my IEP third graders are being tutors to fifth grade students."*

Technology Integration and Teaching

Teachers noted in their journals the ways in which their participation in the TLP had impacted their teaching. Presenting lessons was more effective when they used laptops and presentation devices, and assignments that had a research or information component were considerably more successful when they were able to offer students access to computers and the Internet. Teachers also discussed the rewards that resulted from leadership opportunities, whether in their school, in the district, or with the TLP. And finally, a theme emerged from teacher reflections on how much more *fun* their work had become because of the addition of a strong technology component. Even though it was a stressful and overwhelming year, when students were motivated and enjoyed learning, the dynamic of the classroom changed. Kids had fun and teachers had fun too.

Challenges to Integrating the Curriculum

While the rewards of infusing technology into the curriculum were many, there were challenges to the process as well. Patterns in teacher responses emerged early in the year, and it turned out that there was a remarkable similarity across grade levels in what teachers said. Lack of time for planning was by far the most frustrating challenge, followed by lack of technical support and teacher's inability to solve technical glitches. Other challenges include faulty hardware and software, incompatibility issues between Mac and PC, server problems, space and wiring problems, and student management problems in terms of the 4:1 ratio.

Teachers' experiences and feelings followed a pattern observed in previous years of the project: teachers start the year full of enthusiasm, motivation, and ready to teach with several technology-integrated projects in place. By December, most teachers felt overwhelmed and pressed for time, and looked for holiday break to "explore, test, plan and catch up." Feelings of frustration were compounded, in some cases, by the late delivery and set-up of equipment. Ready to start again in January, they hung on until March, when things generally seemed to be better. Journal reflections took on a much more positive, enthusiastic tone as spring approached: technical glitches became significantly less, the process of designing integrated lessons became more natural, and student accomplishments gave teachers a reason to persevere. Most teachers finished the year more exhausted than usual, but had a greater sense of accomplishment as well. While they were clear in stating that they would not want to repeat the steep learning curve experienced during the first year, there were nevertheless many comments about how it was, in the end, worth all the time, effort, and frustration.

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Beginning of the Year Challenges

Teachers were frustrated by beginning of the year problems related to ordering, delivery, and set-up of the computers and were upset at how complicated and inefficient the process seemed to be. Specific problems included: (1) orders that should have been placed during the summer but were not; (2) confusion about what equipment to order; and (3) orders that were delivered and sat unopened because of limited tech support. Some teachers were disappointed that they weren't told of important specifications about the equipment they ordered, only to find compatibility issues upon set-up. (Schoolkit doesn't work with Mac, wireless "airport" systems aren't compatible with iMacs, etc). Some teachers waited several months for computers, software, networking capabilities, and projection devices, due in large part to district policy, district inefficiency, and /or shortage of technical personnel. The following comments from frustrated teachers were shared in journals:

> *"The challenges I have faced could be the bulk of the journal, if I so desired. I must say,- my school district has not planned well. They delayed ordering equipment until mid September, barely making the deadline. I had stated all along that my plan was to have tables of four students with a computer at each table. Sometime around October 20, I was informed that this would be impossible in my current classroom, because the floor was a concrete slab, and cords would need to be run through the floor for my desired configuration. Then, I had to decide how important it was to me to have students and computers together, and I decided to move my classroom to another available room, ic sthat was to be vacated when a portable classroom opened. The epic of the portables is a whole other story I would rather not get into right now, but the bottom line is that I moved my class on November 3. Yes, after the deadline. The computers were set up in my room on October 31, then moved on November 3. I am still waiting for back-ordered tables to arrive."*

> *"My computers are in my classroom, but they are still sitting in boxes. When they were delivered I was told not to unbox them. I did set up one computer, but my principal told me not to tamper with the others that the district technology personnel would be responsible for setting up the computer and loading the software due to liability issues. Hummm…So, no integration except in the atmosphere of the room for the last two weeks…I have felt very frustrated with the slow process in our district with ordering the computers, delivering the computers and then setting the computers up and getting them ready to use. The wiring for an internet connection was completed at the end of the summer, but the phone connection has not been completed yet."*

Time

While many teachers acknowledged that there is *never* enough time in the teaching profession, they nevertheless found that the integration of technology intensified this problem. While teachers started the year with ideas and a few lesson plans, they needed to continue designing new projects, which takes time: time to experiment with new hardware and software programs, time to find the right place for technology in a lesson or project, time to find effective and efficient management strategies, time to identify Internet sites (especially for primary teachers), and time to fix (or wait for help fixing) technical problems. This was made more difficult because it had to be done "on the run." Many commented about putting in 12-hour days, being the last one to leave every evening, and of alternately feeling excited, overwhelmed, tired, behind, and guilty (for not using the computers enough). Teachers felt that while they had plenty of great ideas, they had little time to implement them. This frustration was expressed in nearly every journal. The following response is representative of teacher reflections:

> *"TIME!!!!! It is difficult to find the time to learn, plan and implement new ideas into the curriculum. It is also difficult to foresee problems and take measures to avoid time intensive delays. I know this will improve as I develop better technology skills, but it is still frustrating now. I hear about great ideas, but have to thoughtfully consider the time and effort involved in integrating new technology ideas into my current curriculum. I feel I must carefully choose when to implement or I could waste valuable time that would be better used elsewhere. It's a difficult dilemma."*

Teachers felt that while they had plenty of great ideas, they had little time to implement them. This frustration was expressed in nearly every journal.

Technical Glitches and Support

A significant frustration for TLP participants was the frequent occurrence of technical problems, and the struggle to get them solved in a timely manner. Technical expertise was not a prerequisite for being selected into the TLP, so many teachers felt stranded when a computer or program quit working. Further, this usually meant that lesson plans for the day had to be scrapped and an alternate plan developed on the spot. Especially problematic were instances where servers went down, or Internet access was otherwise unavailable. Teachers felt that the integration process was, to a certain degree, a lesson in patience. Even when technical support *was* available, getting someone to the classroom in a timely manner was difficult. Teachers who faced this kind of situation were discouraged, since adequate technical support was a stipulation agreed to by cooperating districts when one of their teachers accepted a TLP grant.

Mac-PC incompatibility was an issue as well. Teachers came from districts all over the state, some of which were confirmed "Mac districts" and others that were "PC districts." For some of those teachers in Mac districts, there were continuing difficulties in running two different platforms. Additionally, since all laptops given to participants were PC, some teachers in Mac districts had trouble connecting with their Mac hardware. Finally, those teachers who ordered Mac resources were unable to use SchoolKit lessons, since they were only useful on PCs. Teacher comments suggested that:

> *"The largest challenge is one of being alone on the PC Platform. Everyone else in my building uses the Mac and when students do any work in my room, their work is actually isolated to the art room. The helpful thing is we are now seeing programs like word for both platforms, and with the advent of the USB we are inching closer to interchangeable machines, but we are not there yet. Very few people in my building can give much support because it's like speaking Spanish in a French village. Some understand, some don't."*
>
> *"The district technicians do not make it to the building often, so I have gone the first two months of school without the hub being hooked up and no access to the building server. Only today (October 16) did the technicians finish connecting the hub and getting my classroom on the Internet. I have been quite frustrated with the slow responses on the part of the district technology office."*
>
> *"Our district is slow at getting tech help out to our building. My other TLP friends in the building are going to ask for an in-service by our tech department to train us on simple tech issues so that we can feel more successful with troubleshooting."*
>
> *"Often, the technical issues are SO frustrating! When my partner and I chose PCs over MACs in our MAC based building, we were assured that our building server could be converted to handle both platforms. That hasn't happened yet, so the principal and I spent about an hour trying to get our ZIP drive to work on the PCs so we could put all the Power Point presentations on one computer. I guess we don't have a scuzzy (?) card in the PCs. Then we tried to create a class folder on the district server (which serves both platforms), and couldn't do that. So, unfortunately, the parents won't be able to admire their children's work."*

Space and Wiring Challenges

Integrating technology into the curriculum involved more than placing computers in a classroom, certainly, and one of the complicating factors was the size of the room and the configuration of outlets. Teachers were not always able to set up their equipment the way they felt it would be most beneficial to students because of spacing and electrical constraints. Placement of desks, cupboards, and the like often determined how the computers could be used. In some cases, teachers switched from desks to tables since it gave them more flexibility in room configuration. This challenge was one of the hardest to deal with, since there was little leeway in altering the basic room arrangement. As teachers observed in their journals:

"Another challenge is in arranging the room configuration without having cords running on the floor everywhere or dangling from the wall jacks."

> *"My greatest challenges so far have been the electrical situation in our building. For the first month of school a teacher in my wing was using a microwave and shutting my systems down daily. Since we have put the microwave on a different circuit the only thing that shuts us down is a heater down the hall. These shut downs have sometimes come at critical instructional times such as when I have my presentation projector on."*

Student Management

Another challenge faced by teachers, particularly secondary teachers, was finding effective and efficient ways of managing students with a 4:1 student to computer ratio. While elementary teachers struggled with this issue also, it was made more difficult for those teachers who were limited by 50-mintue time blocks. Teachers across grade levels worked hard to get all students adequate and equitable time on the computers. In many cases this meant teachers had to modify the classroom routine, alternating groups for direct instruction and computer work. Elementary teachers had the flexibility to do this over the course of a day, since students were typically self-contained. Secondary teachers, on the other hand, had to fit lessons into one class period. It was difficult and some teachers were still struggling to find a balance at the end of the year.

> *"Trying to integrate technology with eight computers and thirty kids in 55-minute blocks of time remains the biggest challenge. In an elementary classroom where kids remain with their teacher for most of the day, I can see more flexibility for rotating kids through the computers. In a middle school setting with such short blocks of time, it becomes much more difficult."*

> *"Finally, the most frustrating challenge has been in making six computers work for twenty-seven students. (There is one more computer that has not been installed due to space concerns). I have to find activities that at least half the students can and are willing to do independently while the other half or so of the class uses computers. This is a problem in my class, which includes a half dozen special education students, plus several more very low achieving students."*

Miscellaneous Challenges

Interestingly, some TLP participants felt they were penalized for getting a Gates grant and more computers in their classrooms. Specifically, there were cases where teachers were told they would have their existing technology taken away and given to other teachers in the building. Teachers felt this was an unfair consequence of being awarded the grant:

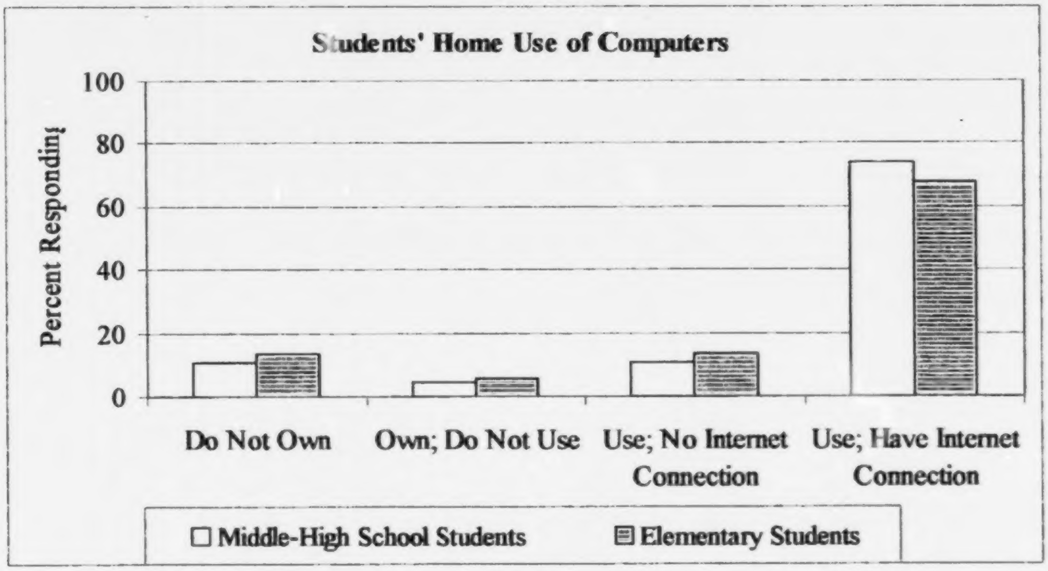
> *"At the beginning of the school year I had three computers in my room for students to use because all of the fourth grade teachers had this amount. We don't have a computer lab this year, so they divided the computers among the teachers. When my computers from this grant arrived, my principal and technology coordinator wanted to take my original three computers away from me. This put me in a very tough situation. I approached my principal and told him that I did not think that this was fair. This grant was something that I earned, and I didn't think that it was right to take computers away from me. Luckily the school board made a policy that they could not take these computers away, so I was able to keep them."*

A fair number of teachers in outlying districts, or in districts with no other TLP participants noted that it would be helpful to have colleagues in their buildings, or in nearby schools with whom they could share ideas, problems, student work, and the like. They found a real need, especially during the first year, to reflect with other teachers about the daily successes and challenges in technology integration. While some teachers across the state would certainly benefit from such a selection policy, it does not align with the philosophy of the Teacher Leadership Project, which is to distribute resources as widely as possible, and to rely on teacher leadership to recruit supportive colleagues within the building.

Students' Technical Skills

Data gathered from the TAGLIT survey offered insight into students' attitudes and competencies related to technology. Of those students who participated in the survey (n = 11,400) it was found that most had and used computers at home (Figure 27).

Figure 27



Students were also questioned about their proficiency in using 15 different applications. Responses indicated that across grade levels, students were competent in similar areas, including draw software, word processing, E-mail, presentation software, the Internet, and CD ROM (Table 4). A breakdown of specific applications shows the extent to which students feel comfortable with each one (Table 4 and Figures 28, 29, 30, & 31). Students indicated that they were least capable with web authoring, multimedia, and databases, as did their teachers.

Table 4

Skill Level of Students with Various Programs and Applications

Secondary Students	%	Elementary Students	%
1. Draw Software	85.8	1. Draw Software	77.9
2. Word Processing	83.2	2. Internet (WWW)	72.8
3. E-mail	81.6	3. Word Processing	70.6
4. Internet (WWW)	78.1	4. Presentation (PP)	68.8
5. CD ROM	73.3	5. CD ROM	63.4
6. Presentation (PP)	69.1	E-mail	61.2

Note: Two levels of response were combined to get the percentage: 3 = "Independent Use" and 4 = "Can Teach Others"

Figure 28

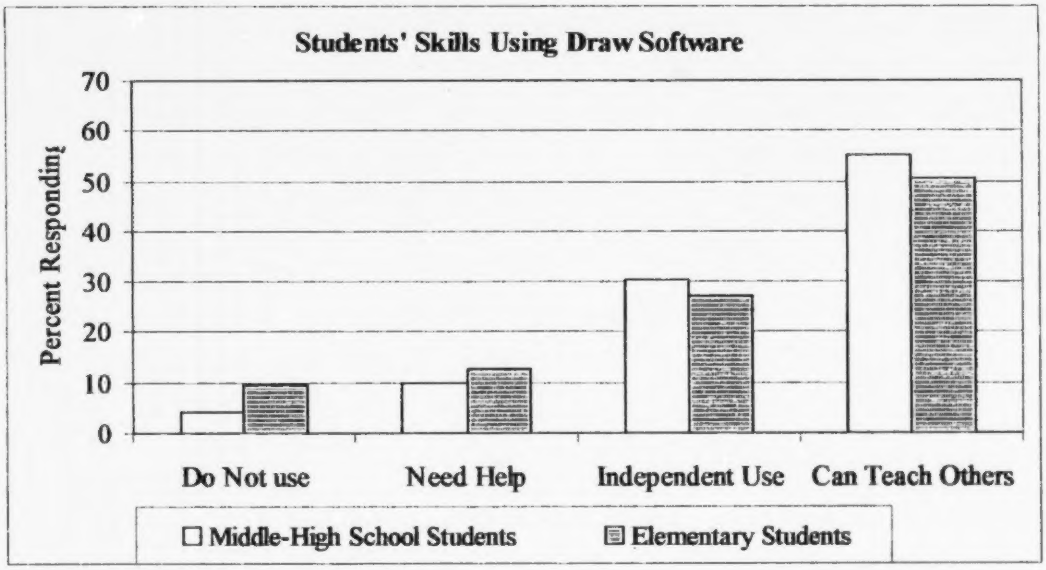


Figure 29

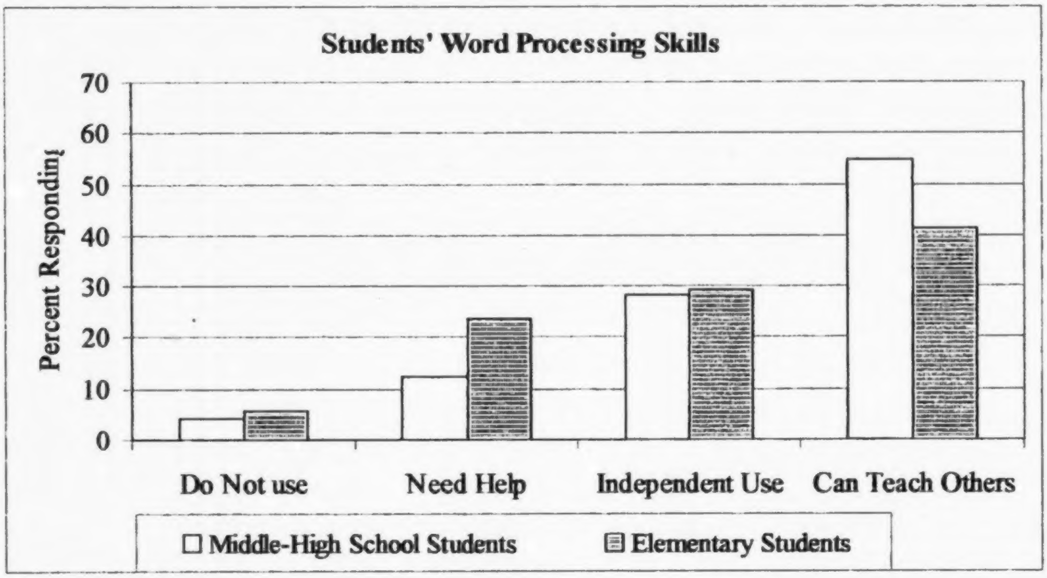


Figure 30

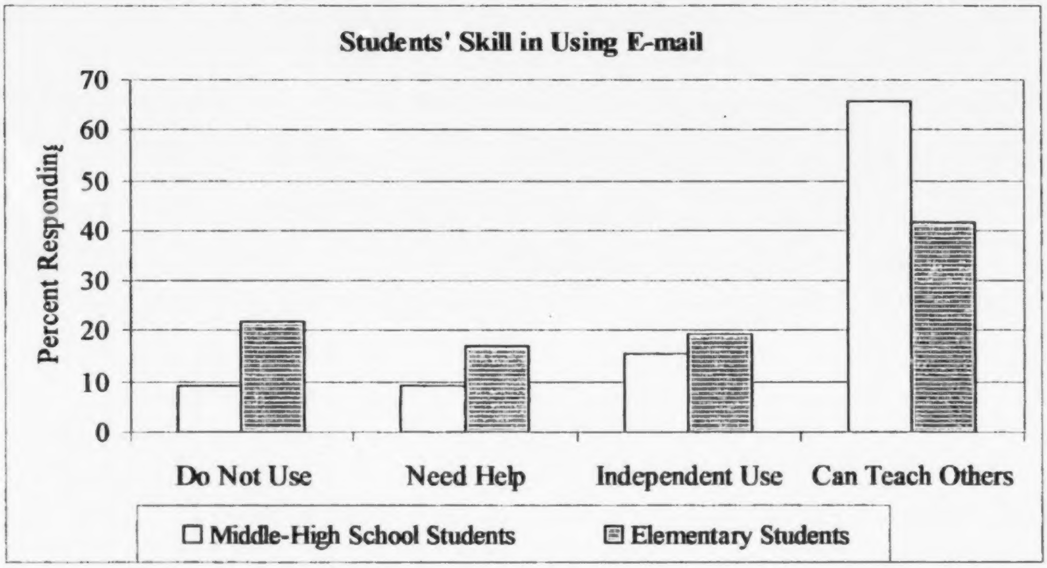
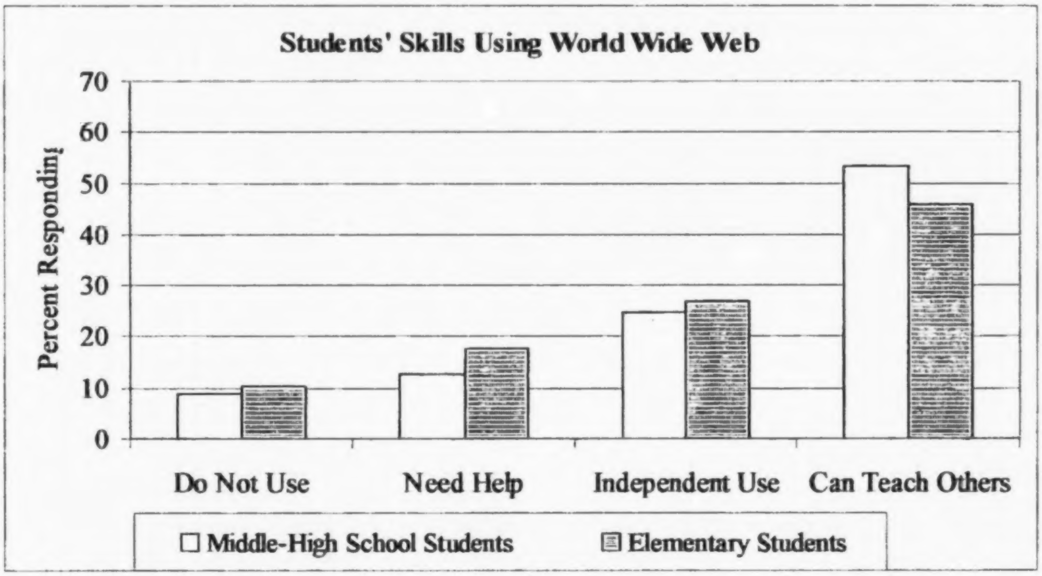


Figure 31



Technology and Teaching Practices

The influence of technology on assessment and interdisciplinary studies was not directly addressed in the evaluation questions. However, teachers indicated that technology did, in fact, influence the ways in which they assessed students (Figure 32). Survey data revealed that 45 percent of secondary teachers and 36 percent of elementary teachers felt that technology integration had strongly influenced their assessment practices. As proponents of school technology have claimed, traditional standardized tests are not adequate for measuring the types of learning that are taking place in transformed classrooms, and teachers are adopting new assessment procedures. TAGLIT data supported this view, it appears, as most teachers indicated their assessment practices had been changed because of the addition of technology.

Teacher responses also indicated that technology had influenced the degree to which they involved their students in interdisciplinary activities. Adding a significant amount of technology to the classroom does seem to necessitate integrated lessons, so it was not surprising that 38 percent of secondary teachers and 37 percent of elementary teachers found this to be true for their classes (Figure 33).

Figure 32

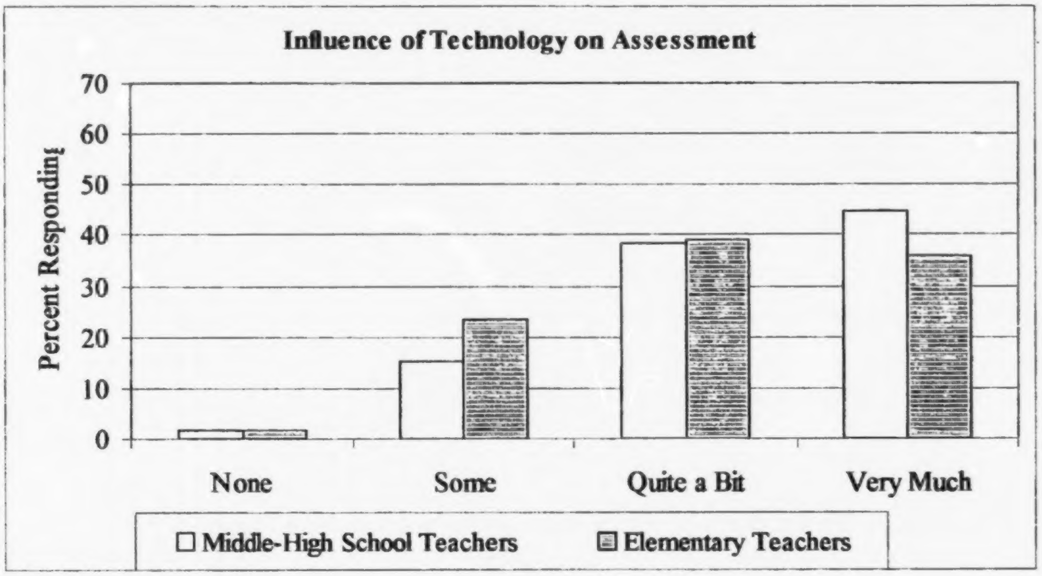
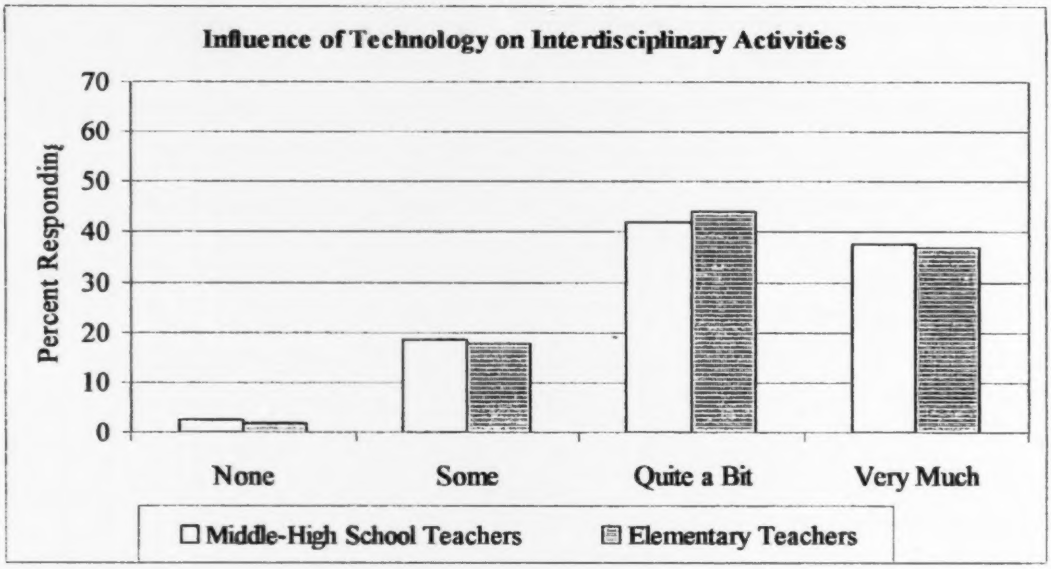


Figure 33

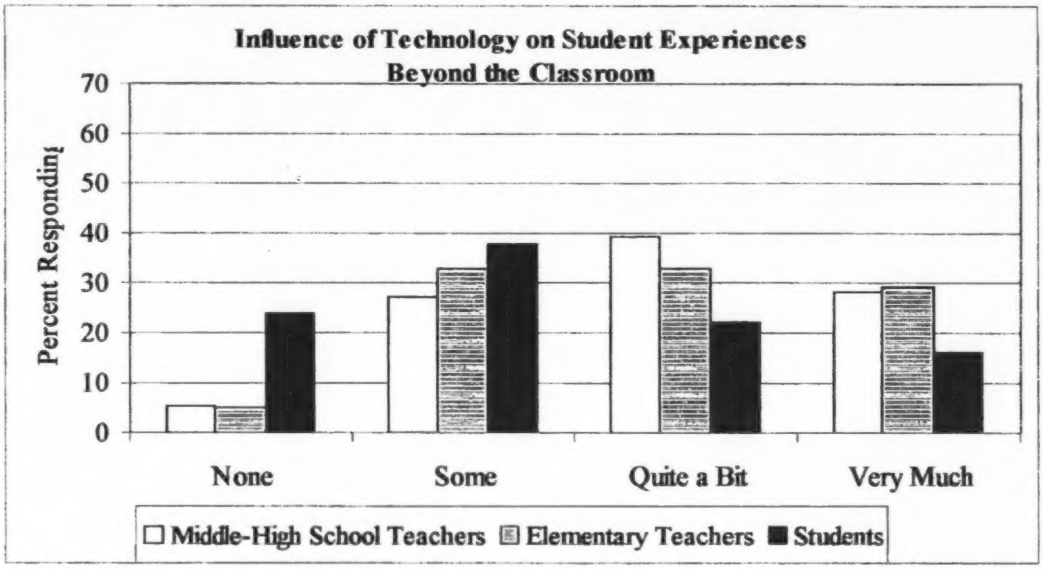


Finally, teachers' perceptions regarding the degree to which technology influenced students' experiences beyond the classroom was mixed (Figure 34). It appeared that while both teachers and students felt their use of technology had some bearing on their experiences outside of school, teachers seemed to believe this more strongly. It might be the case that these students are too young to be thinking about the impact of school outside of the classroom. On the other hand, perhaps there are few instances, other than playing games, where technology intersected with their non-school lives.

Teacher Perceptions on the Teacher Leadership Project and Technology

The rewards of integrating technology into the curriculum were many, clearly, and teachers worked long and hard to utilize the computers effectively and efficiently. While not all teachers reached a "transformational" level of integration during the first year, they nevertheless made significant progress using it in the teaching and learning process. It is interesting to note the tendency for first year teachers to consider integration an "all or nothing" endeavor. There is a sense that the technology should be in use constantly throughout the day, and if (when) it is not, they feel they are not fulfilling the intent of the grant. Second-year teachers seem to better understand the need to find a balance between traditional classroom tools and technology. Time is a critical factor in finding this balance.

Figure 34



It is interesting to note the tendency for first year teachers to consider integration an "all or nothing" endeavor. There is a sense that the technology should be in use constantly throughout the day. Second-year teachers seem to better understand the need to find a balance between traditional classroom tools and technology.

Another interesting observation of TLP teachers was what seemed at times to be an unshakable belief, or conviction, about the value of technology in teaching and learning. It must be recognized that this was a self-selected group of teachers, and therefore they may have started the TLP with preconceived attitudes about the value of technology and education. Nevertheless, they did express a confidence in technology that suggested it is *the* educational reform that will change education. Furthermore, teachers were generally convinced that technology will, at some point in time, have a positive impact on student achievement. Sentiments of second year TLP teachers were similar, although they were not as assertive in their comments. This commitment to the value of technology is interesting, given all the fads and innovations teachers have seen over the years. Changes in instructional strategies, curriculum, the school environment, and schedules come and go, and teachers often grow weary trying to keep up with all the changes. The integration of technology is different, at least according to TLP teachers. It is an educational development that seems to energize and motivate. The U.S. Department of Education supported this view, noting that, "technology supports exactly the kinds of changes in content, roles, organizational climate, and affect that are at the heart of the reform movement" (1993).

Time will tell whether or not technology has the impact on student learning that TLP teachers suppose it will, but for the moment there seems to be a belief in computers that borders on faith. Jane Healy, who argues for caution in using technology with young children, shares a conversation she had with a colleague regarding this attitude. She asked, "Why do we so desperately need to believe in computers? After surveying current attitudes for the nonprofit organization Learning in the Real World, William Ruckeyser told me, 'The nearest thing I can draw a parallel to is a theological discussion. There's so much an element of faith here that demanding evidence is almost a sign of heresy'" (Healy, 1998, p. 19). It is certainly strong testimony to the structure and implementation of the Teacher Leadership Project that teachers support the program and the use of technology so strongly. This is evident in their remarks:

Time will tell whether or not technology has the impact on student learning that TLP teachers suppose it will, but for the moment there seems to be a belief in computers that borders on faith.

> *"Our students' world is forever changing and by getting their hands on to technology now, we are ensuring them more success in school."*
>
> *"What an exciting time in education this truly is! Looking back on how reluctant I was regarding technology and education I am amazed at my own growth and learning with technology, I feel a sense of accomplishment and success... What amazes me most are all the infinite possibilities that are available through technology. Never in my wildest dreams would have I imagined that I would be a technology facilitator."*
>
> *"Integrating technology into the curriculum truly enriches it. I love the at-your-fingertips access to information for students as well as teachers. I love how students naturally become more critical thinkers because they see sources that have conflicting information and therefore need evaluating. I love the students' enthusiasm. If I look back to before TLP, this view is a huge change for me. Before TLP, I didn't have computers in my classroom even for word processing. Until I had the computers and the training, I didn't appreciate how much technology could really add to each day. I have been at my school for ten years. When I think of moving on I am very reluctant to consider any classroom that doesn't have computers and classroom Internet access. Technology now feels essential to my teaching style and I am a firm believer it is the best way to learn."*
>
> *"Before I took the TLP training I thought I knew how to use technology in the classroom. Boy was I off base. The training that I received opened a*

whole new world for me. I believe myself to be a creative and sometimes innovative teacher but now I feel like super teacher..."

"I feel the lack of integration into the curriculum is where we have failed in the past. I have used technology in my class for over 10 years. But before participation in TLP, I was more driven by learning the technology instead of making the technology a byproduct of the curriculum. I can't over emphasize what a revelation this has been for me. The methods I have learned to make technology an outgrowth of what I already teach has really been empowering."

"Being a part of the TLP Gates Grant and all that it entails has been exciting and rewarding. I will continue to look forward to further integrating my curriculum with technology during the next several years. As I look ahead, I see it as a time when each year I will increase my own technology skills and, thus, further enhance my students' learning."

"Thank you to the Gates Foundation, and all of you who have let me have this dream. I always knew I could do better teaching if I had the tools, and I'd say it has worked. I am able to individualize more and kids are eager to try. Being an experience computer user when I came into the grant certainly allowed me to make greater progress. Much of my fun was helping to bring others along. Next year can only get better. I truly see parts of my job getting easier as the kids are equipment to take on more responsibility for their learning."

There was a strong belief among teachers in the potential of technology to change the school experience. They were generally convinced that student learning was transformed when technology was intentionally infused into the curriculum. Teachers are fiercely supportive of the TLP, and believe it is a model of effective professional development.

Summary

While the evaluation of the Teacher Leadership Project focused on six research questions regarding the efforts of teachers to integrate technology into the curriculum, several other areas of interest emerged in analyzing the data. These included specific successes and challenges identified by teachers in using the technology with students, evidence of students' skills and attitudes related to technology, and perceptions of teachers about the TLP and technology in general.

Teachers involved in the TLP found the process of integrating the curriculum to be challenging, and discussed specifically the need for more time to explore software and plan lessons. In this they are not alone. According to a recent survey of over 2,000 classroom teachers about their use of technology, "Among the greatest barriers to the use of technology in instruction was lack of time.....lack of release time for teachers to learn, practice, or plan ways to use computer or the Internet for instruction" (NCES, 2000, p. 95). TLP teachers also felt challenged in what they could accomplish in the classroom, both because of limited technical support and because of equipment problems. As well, many of the TLP teachers struggled with room configuration and student management with a 4:1 ratio issues. Secondary teachers, in particular found it difficult to provide all students with adequate computer time. A similar finding was reported by NCES. "Secondary teachers were more likely than elementary teachers to indicate that not having enough computers was a great barrier" (2000, p. 93). However, although the challenges seemed overwhelming at times, the successes and rewards were far greater. Teachers saw significant improvement and growth in their student's behavior (motivation, independence, collaboration, self-direction), in their technical skills, and in their academic performance (writing, reading, problem-solving, math comprehension, and quality and quantity of work). As well, there were important changes to the classroom environment and in the relationship between the teacher and students, all of which are in line with recommendations from researcher about what and how children should learn in school.

Data also gave insight into students' technical knowledge and skills, revealing that most were competent in the use of draw and word-processing software. A majority of students also felt confident in their abilities to use e-mail, the Internet and CD ROM and presentation software.

Finally, there was a strong belief among teachers in the potential of technology to change the school experience. Based on their own knowledge, as well as classroom evidence, they were generally convinced that student learning was transformed when technology was intentionally infused into the curriculum. Teachers are fiercely supportive of the TLP, and believe it is a model of effective professional development.

CONCLUSIONS AND RECOMMENDATIONS

The Teacher Leadership Project, funded by the Bill & Melinda Gates Foundation and administered by Northwest ESD 189, provides training, hardware, and software to K-12 teachers across Washington state to support their efforts in integrating technology and the curriculum. In addition, teachers are encouraged to take on leadership roles within and beyond their schools and districts, sharing their technical skills and experience using technology to support student learning. The evaluation of the TLP was designed to assess how well these goals were met during the 2000-2001 school year. Data were gathered from several different sources to answer six evaluation questions, including teacher journals on the integration process, the TAGLIT survey, interviews, and classroom observations.

Results suggest that the TLP is an exceptionally strong program, in terms of design, administration, and outcomes. Students and teachers benefited in a number of ways from their participation in the program, as did schools and districts. While the process of infusing technology into the curriculum was time consuming, the impact on teaching and learning was impressive. Given the results of journal analyses and survey data, it appeared that a majority of TLP participants reached a respectable level of integration. Across grade levels, approximately 30 percent of TLP teachers appeared to have reached a level where technology use was both seamless and powerful.

Teachers said that attitudes, process skills, products, and comprehension were all increased, to varying degrees, when students were taught using technology. Reading and writing, mathematical understanding, and problem-solving skills all appear to improve when students have access to computers. Motivation to be at school, to participate in and complete lessons, to go beyond the minimum requirements, and most importantly, to *learn,* can be attributed to computers, according to TLP teachers. Comments from teachers consistently spoke to the increase in collaborative learning that takes place in the classroom when technology is integrated. It was one of the more powerful outcomes of the Teacher Leadership Project, and one which teachers believe will have a positive and long-lasting impact on students and their ability to function in school and beyond.

Teachers were not satisfied with the level of technical support they received over the course of the year. At times they felt powerless in their attempts to communicate with technical support personnel, and were frustrated by a lack of support from district administrators. Quite a few teachers believed that their integration efforts suffered as a result.

TLP teachers and their students responded to the call to share their training beyond the confines of their individual classrooms. Whether they taught classes, offered technical assistance, made presentations, or served on technology committees, teachers shared their knowledge, skills, and resources to raise awareness and develop competencies in the area of technology integration. It seems certain that their time and efforts will have an impact on teaching and learning across the state.

The large majority of TLP participants responded positively about the value of the training they received from the Teacher Leadership Project. As previous participants have observed, the sessions were organized, supportive, and offered a good balance of instruction, sharing, and practice. The only complaint, as such, was that training does not continue after the first year of participation. Teachers believe quite strongly that the TLP would be a stronger program if the professional development component were extended.

While patterns of use, benefits, and challenges have become much more clear over the past four years regarding technology integration in intermediate and middle school classrooms, patterns at the K-2 level have just begun to emerge. It appears, for example, that young children can learn to navigate within and between programs, do basic word processing, design simple Power Point presentations, complete directed Internet searches, and practice basic skills. Questions remain about the necessary and appropriate hardware and software for primary classrooms, the types of training that best support primary teachers in their integration efforts, and management strategies that are effective with a classroom of 5-8 year olds. In light of these remaining questions, it seems prudent to continue the evaluation of the primary component of the Teacher Leadership Project.

Are teachers using the technology as intended? The answer seems to be, unequivocally, yes. Although the first year in the Teacher Leadership Project is one filled with challenges, they are few compared to successes and rewards. Benefits are many, and there seems to be little doubt that the program has strengthened the school experience for students across the state.

Recommendations

1. The training provided by the TLP to teachers, both in the initial summer session and in the follow-up meetings is absolutely essential to the success of the program. While the TLP was expanded considerably during the 2000-2001 school year (214 teachers in 1999-2000; 1000 teachers in 2000-201), the integrity of the training was maintained and even *strengthened* with the implementation of a strong curriculum development component. The direction taken by the TLP in using curriculum frameworks and essential questions as a basis for their training sessions (Wiggins and McTighe) should be continued, since it is likely that this will lead to a higher degree of seamless and powerful integration and greater success for students.

2. In addition, given the research base on educational reform it is suggested that the Teacher Leadership Project consider extending the training provided to participants. While motivation and enthusiasm for the program is high, research and experience indicate that 3-5 years of training and support are necessary for reform measures, such as the TLP, to become institutionalized.

3. As part of their training, teachers should be familiarized with both the strategic and philosophical shifts that are likely to occur when technology becomes an integral part of the curriculum. Instructional strategies, materials, assessment, student management, role and relationship of teacher and student, and types of lessons are all changed to some degree in an integrated classroom. Teachers must be aware of these shifts if they hope to maximize the potential of technology. (See Appendix A)

4. Technical support continues to be one of the most significant challenges to implementing an integrated curriculum, and the TLP has been intentional in requiring participating school districts to provide such support to their TLP teachers. The extent to which the program can monitor and enforce this requirement will influence the movement that can be made by teachers, especially in the first several months of the school year.

5. Given the sometimes significant differences student and teacher perceptions about the place of technology in the classroom and its impact on learning, it would behoove teachers to *talk* with students about the Teacher Leadership Project, if they are not already doing this. Students would benefit in knowing about the intent and structure of the program, and also about their teacher's strategies and goals for infusing technology into the curriculum.

6. Student survey responses indicated that they were seldom required to evaluate information gathered from the Internet for research purposes. Electronic references, like encyclopedias, yearbooks, or any other information resource, must be used wisely. It is imperative that students be taught how to assess material taken from the Internet for accuracy, relevance, and bias, especially since it is being used with such regularity in the classroom.

7. Teachers put considerable time and effort into developing meaningful integrated lessons and projects for their students. Observing the criteria proposed by Roblyer and Edwards (2000) may be helpful to teachers as they reflect on their integration efforts to determine whether or not the costs (time, effort) justify the benefits (student learning). (See Appendix B).

8. Teachers are generally convinced that students are learning more due to their access to technology. While large-scale, longitudinal achievement data for TLP classrooms is lacking, teachers nevertheless should gather and monitor test scores and other evidence of student performance wherever possible. As more evidence is accumulated, it will become easier to quantitatively study the impact of technology-rich environments on student achievement.

Implementation of the TLP at the primary level was generally successful during the first year. However, several modifications would strengthen this component of the program, and are discussed below:

9. Given the short timeline for including primary classrooms in the 2000-2001 TLP program, it is understandable that some issues were not addressed as fully as they might have been. Training sessions, for example, did not completely meet the needs of K-2 teachers. Efforts should be made in future sessions to provide relevant and specific instruction for primary teachers.

10. Primary teachers should be provided with developmentally appropriate software, including but not limited to Word, Excel, and Power Point, and also Kid Pix, Graph Club, and primary reference software. Should primary versions of School Kit become available, those too should be provided.

11. Given the challenge of monitoring young children on computers, it is unclear whether or not K-2 teachers require the same (4:1) ratio of students to computers as do intermediate and secondary teachers. It would be worthwhile to consider modifying the hardware that is currently provided to K-2 recipients. Teachers may be better able to support instruction in primary classrooms with a high quality presentation device, scanner, color printer, digital camera, Alpha Smarts, and *fewer* desktop computers.

12. Primary teachers appear to have questions and needs that are unique to their situations, and which cannot be addressed by intermediate and secondary teachers. It would be useful to establish a separate K-2 listserve so that primary teachers could easily share information and support.

13. While patterns of use, benefits, and challenges have become much more clear over the past four years regarding technology integration in intermediate and middle school classrooms, these patterns have just begun to emerge regarding primary integration efforts. In light of questions that remain about the use of computers with young children, it seems prudent to continue the evaluation of the primary component of the TLP for several years. Findings will benefit not only those involved with the TLP, but also the larger educational community.

14. Compile and distribute a "handbook" to each K-2 participant, to include:
    - Developmentally appropriate websites
    - Scope and sequence / scaffolding plan for introducing technology
    - List of developmentally appropriate, useful software
    - Recommendations on keyboarding instruction and/or programs
    - Room arrangements and space considerations
    - Student management strategies
    - List of reference materials related to primary integration

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Appendix A

Moving from Traditional to New Learning Environments

"Traditional" Learning Environment	New Learning Environment
Teacher-centered instruction	Student-centered learning
Single sense stimulation	Multi-sensory stimulation
Single path progression	Multi-path progression
Single media	Multi-media
Isolated work	Collaborative work
Information delivery	Information exchange
Factual, knowledge-based	Critical thinking and informed
Reactive response	Proactive, planned action
Isolate, artificial context	Authentic, real world context
Passive learning	Active/exploratory and inquiry-based learning

Appendix B

How Do You Know if You are Integrating Well?

- An outside observer sees the technology activity as a seamless part of the lesson.
- The reason for using technology is obvious to you, the students, and others.
- The students are focusing on learning, not on the technology.
- You can describe how technology is helping a particular student.
- You would have difficulty accomplishing lesson objectives if the technology weren't there.
- You can explain easily and concisely what the technology is supposed to contribute.
- All students are participating with the technology and benefiting from it.

How Do You Know When You Haven't Integrated Technology Well?

- You consistently see the technology as more trouble than it's worth.
- You have trouble justifying cost and preparation time in terms of benefits to your students.
- Students spend more time trying to make the technology work than learning the topic.
- The problem you were trying to address is still there.

Roblyer, M.D. & Edwards, J. (2000)

Appendix C

Figure 35
Percent of Teachers who have Reviewed their School's Technology Plan

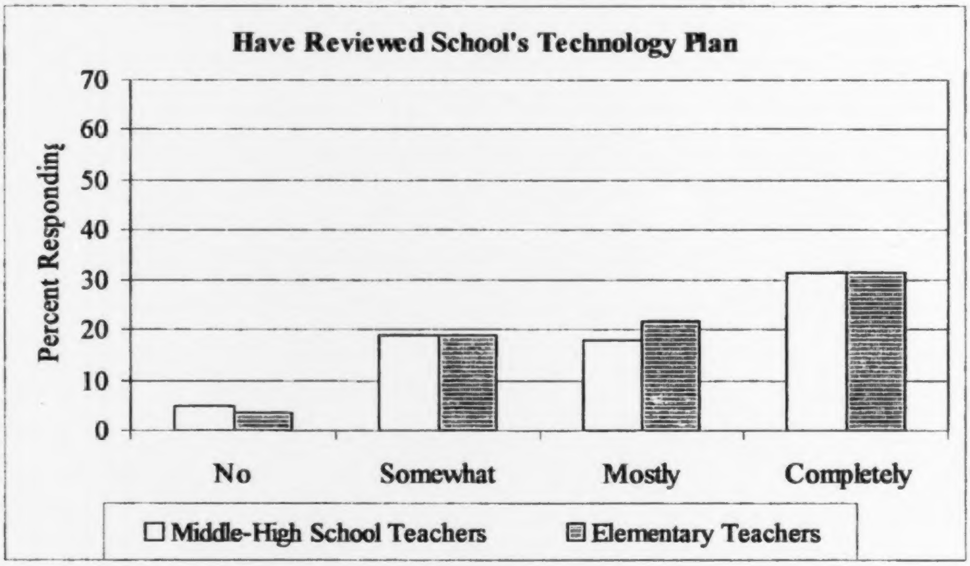
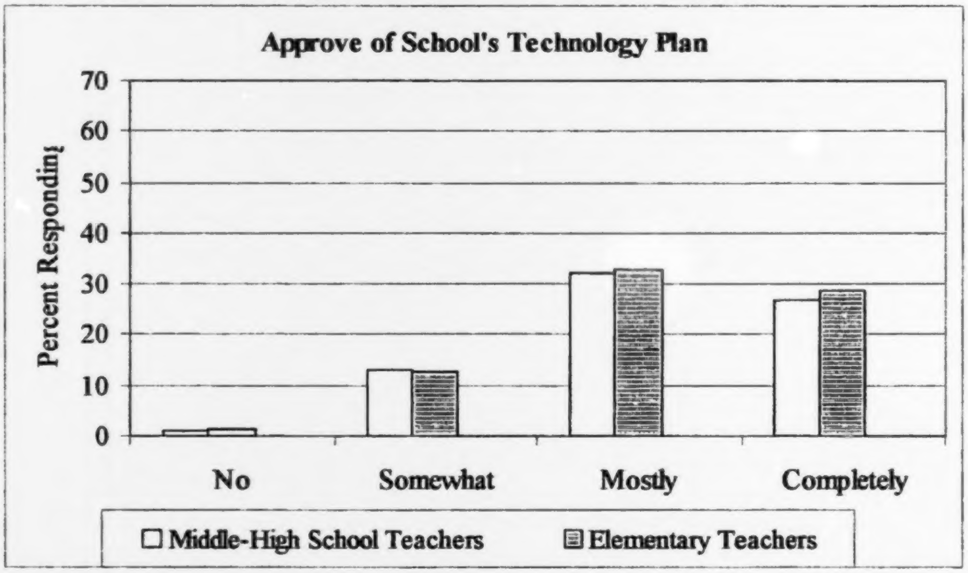


Figure 36
Percent of Teachers who Approved of their School's Technology Plan:



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